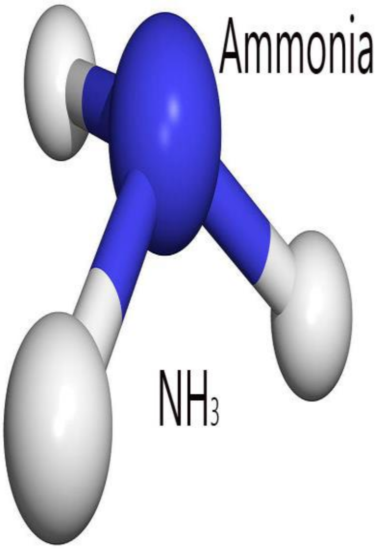
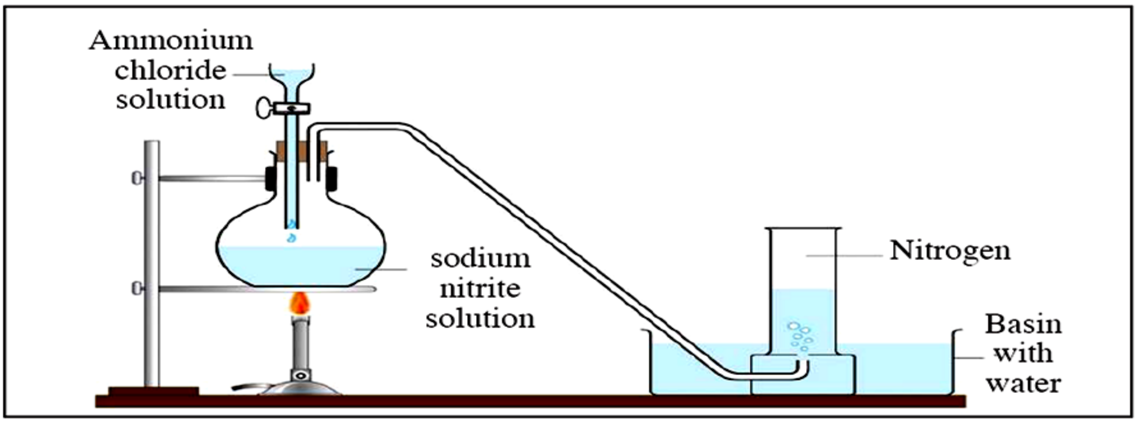
Chemistry

Second Secondary
Second Term





Chapter three

Chemical reaction

Chemical reaction:

- Is the reaction in which the bonds of reactants are broken forming new bonds in products.
- (Inert gases are chemically inactive). Because their outer energy levels are completely filled with electrons (stable elements) where they have high I.P. & low E.A.
- On mixing iron fillings with sulphur the result will be a mixture not a compound.

Because: There is no chemical bond formed between iron and sulphur.

But if this mixture is heated enough to form new bond the result will be a compound called iron sulphide FeS.

Type of chemical bonds:

1) Ionic bond.
2) Covalent Bond.
3) Co-ordinate bond.
4) Hydrogen bond.
5) Metallic Bond.

1)Ionic bond:

- This bond is usually formed between metals and nonmetals. It is known that atoms of metals are characterized by large volumes (atomic radius). Accordingly, their ionization energies are low. This facilitates the loss of their few electrons of the outermost shell. Metal atoms are then changed to cations with an identical electron structure to the nearest noble gas in the periodic table.
- On the other hand, nonmetal atoms are characterized by their small volumes.
  Accordingly, their electron affinities are high this facilitates the gaining of electrons (those lost by metal atoms). Non-metal atoms are changed to anions with an identical electron structure to the nearest noble gas in the periodic table.

- **Consequently, an electrostatic attraction occurs between (+ve) cations & (-ve) anions. It is called the ionic bond.**
- **This means that ionic bond has no materialistic existence.**

Examples: Formation of NaCl:

$$Na \longrightarrow Na^+ + e^-$$
2, 8, 1 → 2, 8

$$Cl + e^- \longrightarrow Cl^-$$
2, 8, 7 → 2, 8, 8

$$Na^+ + Cl^- \longrightarrow NaCl$$

- **Ionic bond is formed between atoms when the difference in E.N between them is higher than 1.7**
- **As the difference in E.N. between atoms increases, the strength of the ionic bond increases which increases the melting point, boiling point and degree of conductivity.**

	Na	Mg	Al	Cl
Electro negativity	**0.9**	**1.2**	**1.5**	**3**
Different in electronegativity	**Nacl 3-.09=2.1**	**Mgcl2 3-1.2=1.8**	**Alcl 3-1.5=1.5**	
Melting point (C)	**810**	**714**	**190**	
Boling point(C)	**1465**	**1412**	**Changing directly from solid to gas (sublimes)**	
Conductivity of electricity	**Very good conductor**	**Good conductor**	**Does not conduct (covalent bond)**	

General properties of ionic compounds:

(1) Structure:

- **These are crystals that are condtructed of collections of cations and anions bound by electrostatic forces in crystal lattice containing the ion in a regular pattern.**

(2) Melting and boiling points:

- **Ionic compounds generally have high melting and boiling points because a great amount of energy is needed to break down the crystal lattic and overcome the strong electrostatic attraction force between cations and anions.**

II- covalent Bond:

- Formed between atoms of non-metals of the same element (have the same electrogativity) or between atoms of different elements have difference in E.N. less than 1.7 it occurs by sharing of valence electrons and is divided into two types:

1- Pure covalent:

Formed between 2 similar atoms have the same E.N(difference in E.N = Zero)

Ex: F_2, Cl_2, O_2, H_2

- In this case, the two atoms have the same E.N. (same ability to attract the pair of electrons to itself). Thus, the electron pair spends the same time in the vicinity of each atom and the net charge on each atom is zero.

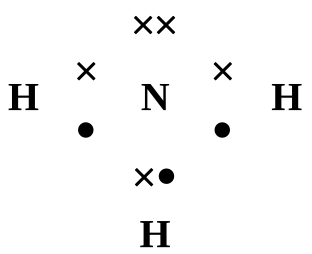
2- Polar covalent:

- Formed between 2 atoms have difference in E.N less than 1.7

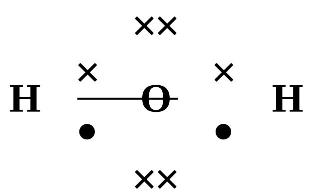
Ex: HCl molecule

- In this case, because chlorine atom has more E.N., so it has greater ability to attract the pair of electrons of the covalent bond (i.e. the electrons spend more time at a chlorine atom). As a result, chlorine atom acquires a partial negative charge (-δ) and not complete one (as in the case of chloride ion Cl-), while hydrogen atom acquires a partial positive charge (+δ).

Polar molecules:







Ammonia (NH_3) Water (H_2O) Hydrogen chloride

General properties of covalent compounds:

1) Electrical conductivity:

- Ions are responsible for electrical conductivity in solutions. Since covalent compounds are not normally ionizable, so they do not conduct electric current as liquids or in aqueous solution.

2) Melting and boiling points:

- Covalent compounds are characterized by their relatively low melting & boiling points due to the very weak attraction force between their molecules which needs low amount of thermal energy to be separated.

Give reason: Solution of HCL in benzene does not conduct electricity, but its solution in
H_2O is a good conductor of electricity.

Answer: Because HCL is a polar covalent compound which can diffuse in benzene (non
polar solvent) but can't be ionized into (+ve) ion (H+) & (-ve) ion (CL-), so it can't conduct electricity. While HCL in H2O (polar solvent) can be ionized into ions which can migrate to the opposite electrodes and so conducts electricity.

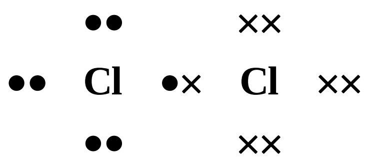
$$HCL + H_2O \longrightarrow H_3O^{+} + CL^{-}$$

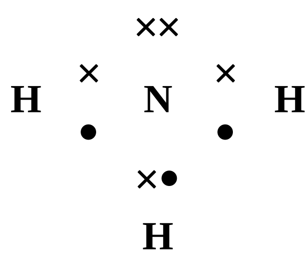
Explanation of covalent bonds:

(1) Electronic theory of valency: (Octet rule Theory)

- Lewis and kosel scientist supposed that:
" all atoms of elements have tendency to reach the octet structure of the outer energy level for the nearest inert gas expect ……..''

Example:



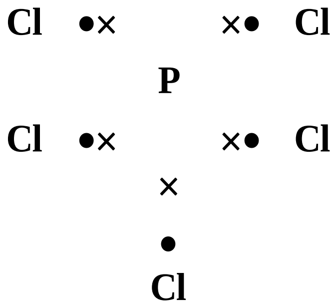


• Defects of electronic theory of valency:

(1) It failed to explain the binding in many molecules.
Which No of e is around central atom is more or less in which than 8

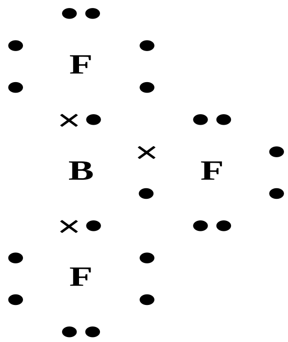
(i) In PCL5:

Phosphorus is surrounded by 10 electrons.



(ii) In BF3:

Boron is surrounded by 6 electrons.



(2) It couldn't explain some properties of molecules as stereo structure and angles between bonds.

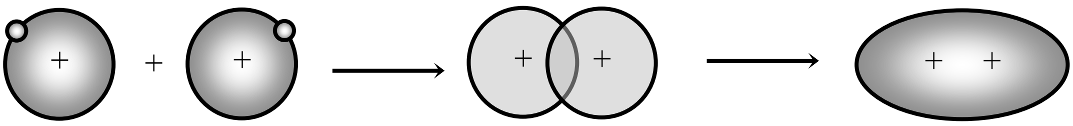
Give reason: Octet rule can't be applied for PCI and BF3.

• The valency Bond Theory: (V.B.T.)

- Electrons has wave property so the formation of covalent bond as a result of overlapping of an atomic orbital of an atom with an unpaired electron, with another orbital in another orbital in another atom has an unpaired electron to form a molecular orbital contains a pair of electrons.

1- H_2 Molecule:

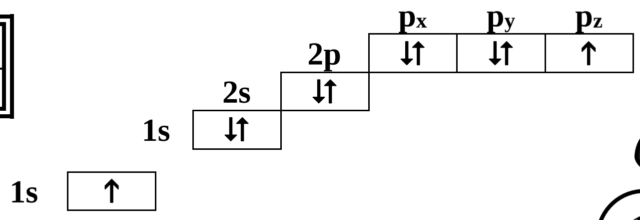
H2 molecule is formed as a result of overlapping of the e' of 1s orbital of each atom

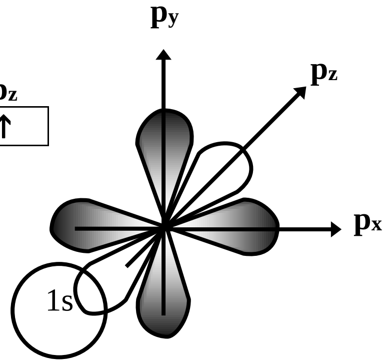


2- HF molecule: 1H 1S

HF molecule is formed as a result of overlapping of 1S atomic of H atom with 2P atomic orbital of F atom.

$_9F$	$1s^2 - 2s^2 - 2p^5$
$_1H$	$1s^1$





3-NH3 molecule:

H_1 : $1S^1$

N_7 $1S^2$, $2S^2$, $2P^1{}_x$, $2P^1{}_y$, $2P^1{}_z$

- **NH_3 is formed as a result of overlapping of**

P_x , p_y ,p_z Orbitals of (N) atom with 3(1S) orbitals of hydrogen atoms.

Q: How does the valence bond theory explain the structure of methane?

- **There are 2 single electrons in carbon atom, but in methane molecule, the carbon atom forms 4 covalent bonds. So, the carbon atom must have 4 single electrons. How?? By exciting one electron from 2S to the vacant orbital 2P.**
- **Now, the carbon atoms has 4 single electrons, but they aren't equivalent in energy as one electron is located in 2S orbital which is lower in energy than 2P orbital. Then they must be = in energy. How?? By hybridization between one orbital of 2S and 3 orbitals of 2P forming 4 orbitals equivalent in shape and energy.**

- **Each of the hybridized orbitals in a carbon atom contains a (-ve) electron. These orbitals must go as far a part as possible from the other orbitals to decrease the repulsion forces between orbitals. When the angles between orbitals are 109 28, they will be more stable (less repulsive) compared to angles of 90 (an alternate structure). To complete the methane molecule, the four equivalent electrons of the four hybridized orbitals of the carbon atom can overlap with the 4(1S) electrons of the 4 hydrogen atom.**

- **<u>Explain methane Molecular Structure: ($CH4$):</u>**

  (1) Type of hybridization: SP^3.

  (2) Angle between bonds: 109- 28

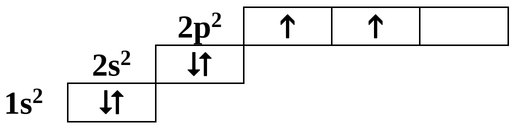
  (3)Stereo structure: tetrahedron pyramid.

  (4)Bonds: Single covalent bond of the type sigma.

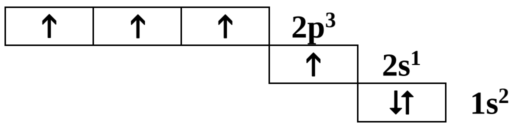
4 (c – H) bonds formed du to overlapping of $4SP^3$ orbitals of one carbon atom with 4(1S) orbitals of 4 hydrogen atoms

- **Methane is chemically in active, due to the presence of 4 sigma bonds in its structure which are very strong (can't be broken easily), so great amount of energy is needed to break them down.**

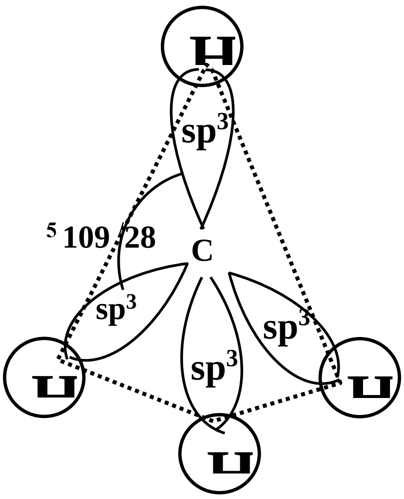
<u>How does the valence bond theory explain the structure of methane:</u>

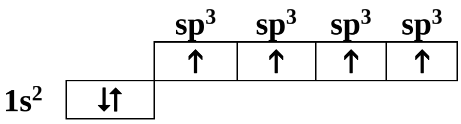


Carbon atom in the ground state



Excited carbon atom





Hybridized carbon atom

- **Hybridization:**

"Is the combination of orbitals of close energy in the same atom to form a number of equivalent orbitals that can take part in chemical combination."

- **Properties of hybridization:**

(1)Hybridization occurs between orbitals of close energy for the same atom.
(2)Hybridization occurs after excitation.
(3) Number of hybridized orbitals equal number of pure orbitals taking part in hybridization.

Example:

Hybridization of 1S with 1P gives 2SP orbitals.
Hybridization of 1S with 2P gives 3SP^2 orbitals.
Hybridization of 1S with 3P gives 4SP^3 orbitals.

(4) Hybridized orbitals are equal in shape and energy; also angles between them are equal.
(5) The shape of the hybridized molecular orbitals differ from these of the pure atomic orbitals forming them. The hybridized molecular orbitals must protrude to the outside to be more capable of overlapping than the pure atomic orbitals.

Molecular Orbital Theory: (M.O.T)

- **Considers the molecule as one unit (or a big atom with multi – nuclei) in which some of atomic orbitals of the combined atoms overlap forming molecular orbitals.**
- **The molecular orbitals have symbols sigma (δ) & (Л)**

Compare between sigma & (pi) bonds:

Sigma Bond (δ)	Pi-Bond (Л)
1- It is formed by overlapping of atomic orbitals head to head.	1- It is formed by overlapping of atomic orbitals side by side .
2- Overlapped orbitals are one the same axis (same line)	2- Overlapped orbitals are parallel .
3- Collinear overlap .	3-Collinear overlap .
4- Strong due to great orbital overlapping (high electronic density) .	4-weak due to lees orbital overlapping (LOWER
5- Between(a)pure – hybridized orbitals (b)Hybridized-hybridized orbitlas	

6- Makes organic compounds less active	6-Makes organic compounds more active

Explain ethylene molecular structure : { C_2H_4 } (ethane)

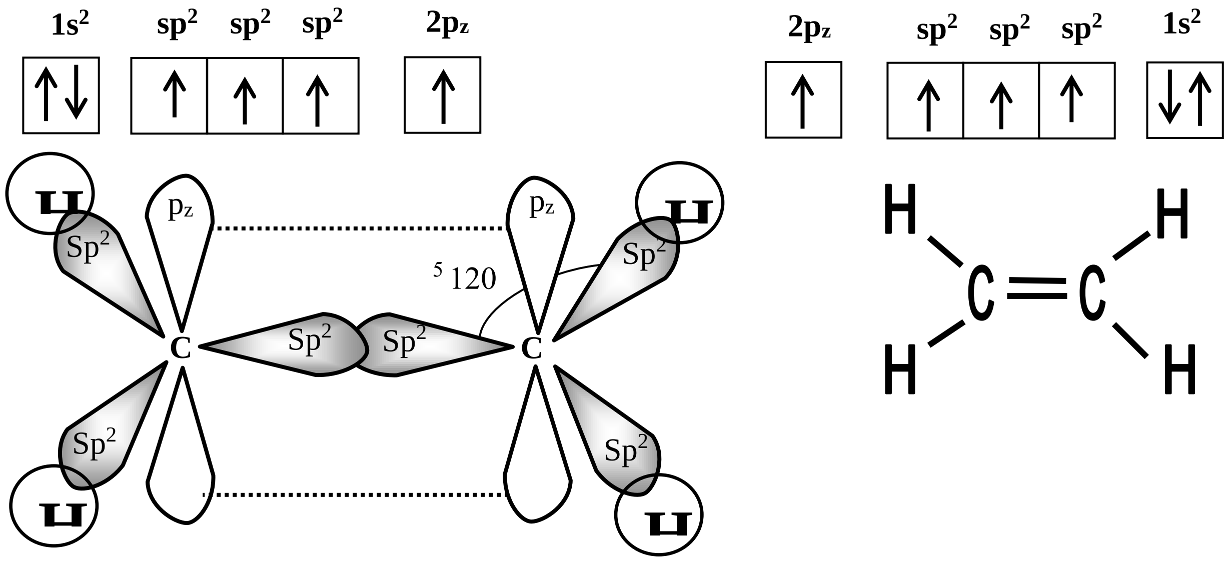
(1) type (kind) of hybridization = sp^2

(2) angle between bonds = 120 º

(3) stereo structure = planer triangular structure .

(4) bonds : di – cover bond of the type sigma and pi .

- {C—C } formed due to overlapping of one sp^2 orbital of a c atom with another sp^2 orbital of a another c atom . { sigma }
- {C—C } formed due to overlapping of pure $2p_z$ orbital of a c atom with another $2p_z$ orbital of a another c atom . { pi }
- {C —H } formed due to overlapping of one sp^2 hybridized orbital of a c atom with one pure (1S)orbital of H atom . { sigma }



Explain acetylene molecular structure :

(1) type of hybridization : sp

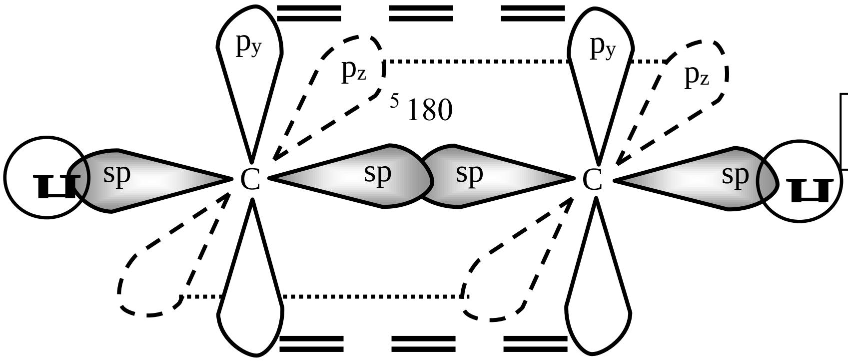
(2) angle between bonds : 180º

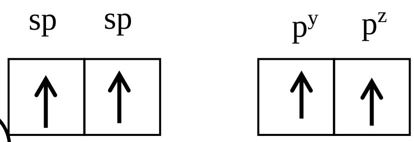
(3) stereo structure : linear structure .

(4) bonds : tri – covalent bond .

- { C— C } formed due to overlapping of one sp orbital of c atom With one sp orbital of another c atom . { sigma }

- { C—H} formed due to overlapping of one sp orbital of c atom With pure 1S orbital of one hydrogen atom . { sigma }
- { C— C} formed due to overlapping of one $2p_y$ orbital of c atom With another pure $2p_y$ orbital of another C atom{ pi }
- { C— C} formed due to overlapping of one pure $2p_z$ orbital of c atom With another pure $2p_z$ orbital of another c atom{pi}





H–C≡C–H

Point of comparison	Methane CH_4	ethylene C_2H_4 (ethane)	Acetylene C_2H_2 (ethane)
No and type of hybridization	$1s+3p=4sp^3$	$1s+2p=3sp^2$	1s +1p = 2sp
Angle between bonds	109o 28	120o	180o
Stereo structure	Tetrahedron pyramid	Planer triangle	Liner

III – Co – ordinate bond :-

" is a type of covalent bond formed between 2 atoms on of theme has one Orbital containing alone pair of electrons which is called donar atom , while The other atom has a vacant orbital called acceptor atom '

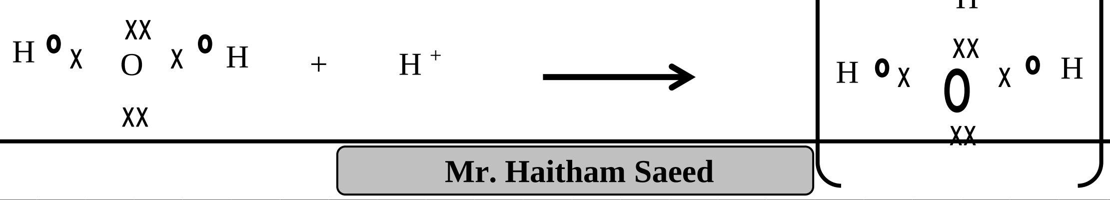
The lone pair of electrons are original from one atom .

Example :

<u>(1) hydronium l on (hydroxonium) H3O+</u>

Is formed when a strong acid dissolved in water :

(donor) (proton acceptor) (Hydronium ion)



<u>Give reason:</u> proton of stong acid does not exist freely in water

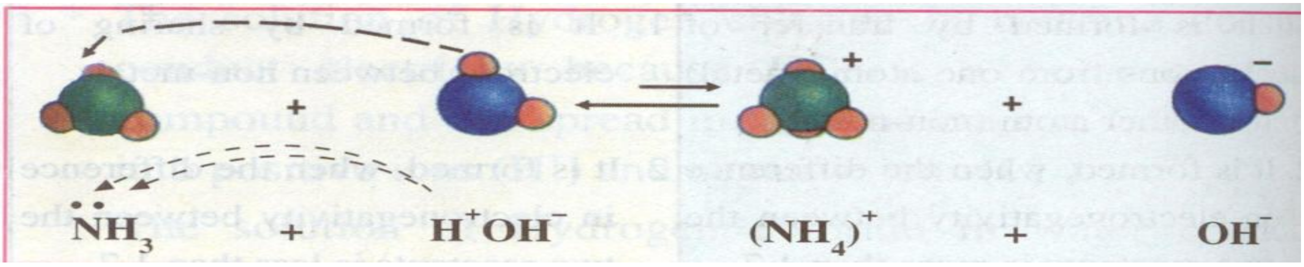
(3) <u>Ammonium Ion (NH_4) + :</u>

-in the last example , proton is acceptor while central atom is donor like oxygen in H_3O^+ , phosphorous in PH_4^+ & nitrogen in NH_4^+.

-also types of bonds in the last examples are polar covalent and co – ordinate bonds .

Q : compare between covalent and co-ordinate bonds .

Definition with examples .



<u>IV – Hydrogen bond</u> :

***is a bond formed between polar molecules in which hydrogen atoms lies between to atoms of high electron gativity as (oxygen) or (fluorine) , so the hydrogen atom binds with one atom by polar covalent bond and binds with the second atom by hydrogen bond .**

****So hydrogen atom acts as a bridge to bind molecules together .**

Explanation of hydrogen bond in water :

(1) oxygen atoms has small volume , so it has high electronegativity (3.5) , while electronegativity of hydrogen is 2.1 . so oxygen atom will carry a -8 charge , while hydrogen atom will carry a (+ s) charge .

(2) hydrogen bond is formed due to the attraction force between one hydrogen atom of one molecule and one molecule and one oxygen atom of another molecule , so molecule of water are collected by hydrogen bonds , so water exists in a liquid state and has high boiling point .

-2δ $+\delta$ -2δ $+\delta$

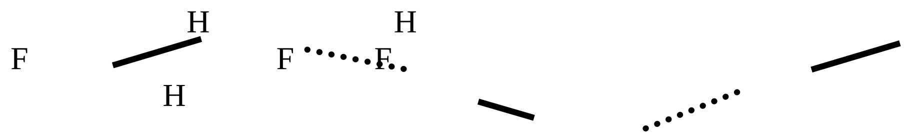
/ O — H ····· / O H

$+\delta$ $+\delta$

Give reason: Although molecular weight of water (H_2O) is very small (18) but it exists in a liquid state and boils at 100 C, while molecular weight of hydrogen sulphide (H_2S) is (34) but it exists in a gaseous state and boils at (-61 C).

Answer: Due to the presence of big difference in E.N. between hydrogen and oxygen and so formation of hydrogen bond between molecules of water.

- Hydrogen Bond in HF:



Give reason: Although sugar is covalent compound but it dissolves in water.
Answer: Due to formation of H_2 bond between hydroxyl group of sugar & oxygen of H_2O, but its solution is a bad conductor of electricity because it can't be ionized.

- Properties of hydrogen bond:

1- **Strength of H-Bond depends on the difference in electronegativity increases, the strength also increases and the boiling point will be high as in water.**

2- **H-Bond is longer than covalent bond.**

3- **H-Bond is much weaker than covalent bond.**

4- **H-Bond has several forms:**
   A- Straight line. B- Closed ring. C- Open net.

	Covalent bond	H2 Bond
B.L.	1 A	3 A
Strength in (k.j)	418	21

V- Metallic Bond (between atoms of metal in the metallic structure):

"Is formed from electron cloud of the free valence electrons around (+ve) metal ions."

- **The free valency electrons of the outer shell are associated together forming an electron cloud which decreases the repulsion force between (+ve) ions in the metallic structure. The strength of the metallic bond depends on no of free valnce electrons. As the no of free valence electrons increases, the atoms of metal will be strongly bonded, so the metal will be harder, of higher melting & boiling points and higher thermal and electrical conductivity.**

- **Give reason: elements of group IA as Na are soft and have low melting point while elements of group IIIA as AI are hard and have high melting point.**

- **Answer: In case of Na: due to weak metallic bond which depends only on one electron from ns, while in case of Al: due to strong metallic bond which depends on three valency electrons of ns, np.**

Give reason: elements of 1st transition series are hard except Cu is relatively soft and has low melting point.

Answer: in case of T.E: due to strong metallic bond as it depends on electrons of 4s & 3d but Cu_{29} ( ) due to weak metallic bond which bond which depends only on one electron of 4S.

- **Explain types of bond in the following:**

Nacl	**water**	**hydronium ion**	**chlorine molecule**
Iron	**Aluminum**	**Ammonium chloride**	**Hydrogen Fluoride**

- **Note:**
  - **Ionic compounds dissolve in polar solvent (H2O).**
  - **Polar compounds as HCL dissolve in polar and non polar solvents.**

Questions

The concept of the chemical reaction

1 **The molecule of the element with an electronic configuration $1s^2$, $2s^2$, $2p^6$ consists of ....**

(a) one atom.
(b) two atoms.
(c) three atoms.
(d) four atoms.

Lewis electron-dot symbols

2 **What is the number of the unpaired (single) electrons in $_7N^{3-}$ ion ?**

(a) Zero
(b) $1e^-$
(c) $2e^-$
(d) $3e^-$

3 **Which of the following molecules includes three bond pairs ?**

(a) HBr
(b) H_2O
(c) NF_3
(d) O_2

4 **What is the number of the electrons required for the covalent bonding in methane molecule CH_4 ?**

(a) $10e^-$
(b) $8e^-$
(c) $4e^-$
(d) $2e^-$

5. What is the number of the lone pairs of electrons on arsenic atom $_{33}As$ in arsine AsH_3 ?

(a) Zero

(b) 1

(c) 2

(d) 3

6. All the following molecules include lone pairs of electrons, except ....

(a) HCl

(b) $MgCl_2$

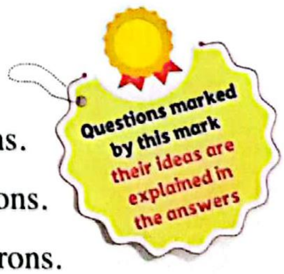
(c) HF

(d) NCl_3

7. Which of the following choices represents the number of the free electrons and that of the bond electrons in phosphorus atom $_{15}P$ in PCl_3 compound ?

Choices	Number of the free electrons	Number of the bond electrons
(a)	1	3
(b)	2	6
(c)	2	3
(d)	4	4

8. Which of the following choices represents one of the atoms forming the molecule of hydrogen cyanide HCN ?



(a) Carbon atom $_6C$ within the molecule has one lone pair of electrons.

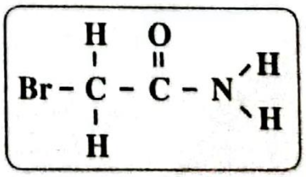
(b) Nitrogen atom $_7N$ within the molecule has one lone pair of electrons.

(c) Hydrogen atom $_1H$ within the molecule has one lone pair of electrons.

(d) Nitrogen atom $_7N$ within the molecule has two lone pairs of electrons.

9. In the structural formula of the opposite compound :

What is the total number of the valence electrons of the atoms forming the molecule of this compound which do not participate in forming the bonds ?



(a) 6

(b) 8

(c) 10

(d) 12

Types of bonds

Which of the following compounds its solution is characterized by its ability to conduct electricity ?

(a) C_2H_4
(b) KCl
(c) CH_4
(d) C_2H_6

Which of the following values may represent the difference in electronegativity between the atoms of a compound which is a good electrical conductor ?

(a) 0.4
(b) 1.2
(c) 1.5
(d) 2.1

In which of the following compounds does the ionic character predominate ?

(a) CH_3Cl
(b) CH_4
(c) Cl_2
(d) RbCl

Which of the following elements of group (2A) forms compounds that exhibi the properties of the covalent compounds ?

(a) $_4Be$
(b) $_{12}Mg$
(c) $_{20}Ca$
(d) $_{38}Sr$

The chemical formula of the compound produced by the combination of element Y : [Ne] , $3s^2$, $3p^4$ with element X : [Ne] , $3s^1$ is ....

(a) XY_2
(b) X_2Y
(c) YX
(d) XY

15 Which of the following ionic compounds its cations and anions do not contain the same total number of electrons ? [H = 1 , Li = 3 , N = 7 , F = 9 , Na = 11 , Cl = 17 , Ti = 22]

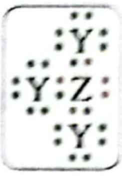
ⓐ LiH

ⓑ NaOH

ⓒ NH_4F

ⓓ $TiCl_3$

16 The opposite figure represents ....



ⓐ an ionic compound.

ⓑ a polar covalent compound.

ⓒ a pure covalent compound.

ⓓ an acid.

17 The opposite table shows the atomic numbers of the two elements X and Y, and the charge of the ion of each of them when it combines with magnesium ion.

Element	Atomic number	Charge of the ion
X	n	– 2
Y	n + 1	?

What is the type of the bonding which would occur between the atoms of the two elements X and Y, and what is the formula of the compound produced by their combination together ?

Choices	Type of bonding	Chemical formula
ⓐ	Ionic	XY_2
ⓑ	Covalent	XY_2
ⓒ	Ionic	X_2Y
ⓓ	Covalent	X_2Y

18 In terms of the opposite table :

Which of the following bonds is more polar ?

Element	H	C	N	O
Electronegativity	2.1	2.5	3	3.5

ⓐ C – H

ⓑ N – H

ⓒ O – H

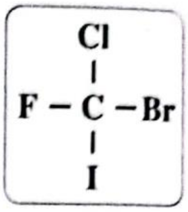
ⓓ C – O

Which of the following compounds is more polar ?

[Knowing that the electronegativities of their elements are : H = 2.1 , N = 3 , O = 3.5 , F = 4]

ⓐ NH_3
ⓑ NF_3
ⓒ NO_2
ⓓ HF

Which of the halogen atoms that surround the carbon atom in the opposite molecule attracts the bond electrons more ?



ⓐ I
ⓑ Br
ⓒ F
ⓓ Cl

Which of the following two elements the covalent bond that arises between their atoms is the most polar ?

ⓐ Chlorine and bromine.
ⓑ Chlorine and iodine.
ⓒ Fluorine and chlorine.
ⓓ Fluorine and iodine.

The electronic theory of valency

Lewis and Kosel theory can be applied to the molecule of ....

(a) PCl_3

(b) PCl_5

(c) BF_3

(d) BCl_3

Which of the following compounds does not obey the octet rule ?

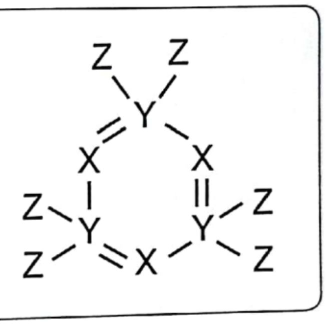
(a) NF_3

(b) PF_3

(c) IF_3

(d) SbF_3

In the opposite structural formula.
What are the probabilities of the elements (X) , (Y) and (Z) ?



Choices	(X)	(Y)	(Z)
(a)	$_5B$	$_{15}P$	$_8O$
(b)	$_7N$	$_{15}P$	$_{17}Cl$
(c)	$_7N$	$_{16}S$	$_{17}Cl$
(d)	$_{15}P$	$_{14}Si$	$_1H$

The valence shell electron pair repulsion (VSEPR) theory

Which of the following compounds molecules contains 2 bond pairs and 2 lone pairs of electrons ?

(a) NH_3

(b) SO_2

(c) H_2S

(d) BF_3

What is the number of each of the bond pairs and the lone pairs of electrons in the central atom of IF_5 molecule ?

Choices	Number of bond pairs of electrons	Number of lone pairs of electrons
(a)	5	1
(b)	5	0
(c)	1	5
(d)	1	4

6 In which of the following compounds does the central atom carry two lone pairs of electrons ?

(a) Ammonia.
(b) Chlorine trifluoride.
(c) Methane.
(d) Phosphine.

7 Which of the following molecules contains the highest number of the lone pairs of electrons ?

(a) F_2
(b) CH_4
(c) CO_2
(d) H_2O

8 The arrangement of the electron pairs on the central atom is being similar to the stereostructure of the molecule when ....

(a) the central atom does not contain any lone pairs of electrons.
(b) the molecule obeys the octet rule.
(c) the value of (n) is less than 4
(d) the value of (m) is higher than 0

10 What is the stereostructure of the molecule of $CHCl_3$?
- (a) Angular.
- (b) Planar triangle.
- (c) Tetrahedron.
- (d) Three-base pyramid.

11 Which of the following pairs of molecules is similar in the stereostructure ?
- (a) H_2O and Cl_2O
- (b) BF_3 and BeF_2
- (c) CH_4 and NH_3
- (d) H_2O and NH_3

12 Which of the following two molecules are similar in their stereostructure ?
- (a) BF_3 , NH_3
- (b) $BeCl_2$, H_2O
- (c) CCl_4 , CH_4
- (d) PF_3 , IF_3

13 Which of the following two molecules both have linear stereostructure ?
- (a) BF_3 , NH_3
- (b) H_2O , SO_2
- (c) BeF_2 , CO_2
- (d) BF_3 , SO_2

14 SO_3 molecule is similar to SO_2 molecule in ....
- (a) the stereostructure.
- (b) the arrangement of electron pairs.
- (c) the number of the electron lone pairs.
- (d) the number of the electron bond pairs.

15 Which of the following choices represents the stereostructure of $BeCl_2$ molecule, as well as the polarity of its bonds relative to the polarity of the bonds of H_2O ?

[Knowing that the electronegativities of their elements are : $_4Be = 1.5$, $_1H = 2.1$, $_{17}Cl = 3$, $_8O = 3.5$]

Choices	Stereostructure	Polarity compared to H_2O
(a)	Linear	Greater
(b)	Angular	Equal
(c)	Linear	Equal
(d)	Angular	Less

16 If the total number of both the lone and the bond pairs of electrons found in the orbitals of the central atom of a covalent molecule is 4, then the stereostructure of this molecule might be ....

(a) linear, angular or planar triangle.

(b) angular, tetrahedron or linear.

(c) tetrahedron, angular or three-base pyramid.

(d) three-base pyramid, planar triangle or angular.

17 What is the stereostructure and the number of the free electrons in the central atom of the molecule formed by the combination of the atoms of the two elements $_{32}X$ and $_{17}Y$ together ?

Choices	Stereostructure of the molecule	No. of the free electrons in the central atom
(a)	Tetrahedron	Zero
(b)	Three-base pyramid	Zero
(c)	Tetrahedron	4
(d)	Planar triangle	4

18 In which of the following molecules would the angle between the bonds be the highest ?

(a) CO_2

(b) BF_3

(c) CCl_4

(d) NF_3

19 The angle between the bonds is the lowest in the molecule of ....

(a) NH_3

(b) CH_4

(c) SO_2

(d) H_2S



20 In OF_2 molecule, the value of the angle between the bonds is ....

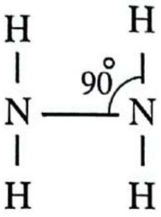
(a) 109.5°

(b) higher than 109.5°

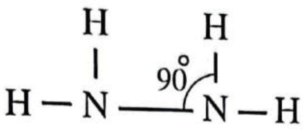
(c) lower than 109.5°

(d) 180°

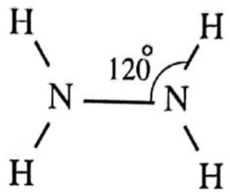
21 What is the expected shape of hydrazine molecule N_2H_4 ?



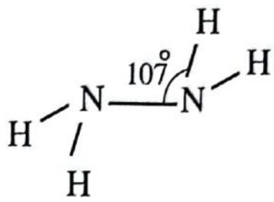
(a)



(b)



(c)



(d)

22 The partial charge on the carbon atom in O = C = O molecule equals ....

(a) zero

(b) δ^+

(c) δ^{+2}

(d) δ^{-2}

23 Which of the following sets of molecules is ordered descendingly according to the values of the angles between the bonds in each molecule ?

(a) $CCl_4 > CO_2 > NF_3 > BF_3$

(b) $CO_2 > BF_3 > CCl_4 > NF_3$

(c) $CO_2 > NF_3 > BF_3 > CCl_4$

(d) $CCl_4 > BF_3 > CO_2 > NF_3$

The valence bond theory

1 According to the valence bond theory.
Which of the following orbitals undergo overlapping to form bromine molecule Br_2 ?

- (a) $3s$
- (b) $3p$
- (c) $4s$
- (d) $4p$

2 Hybridization process can take place between the orbitals of the sublevels ....

- (a) $1s$, $1p$
- (b) $2s$, $2p$
- (c) $5s$, $3d$
- (d) $4d$, $3p$

3 When the hybridization in the molecule is sp^3, the arrangement of the electron pairs in the space will be ....

- (a) tetrahedral.
- (b) three-base pyramid.
- (c) planar triangle.
- (d) angular.

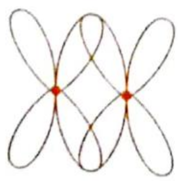
4 What is the type of hybridization in ammonia molecule $\ddot{N}H_3$?

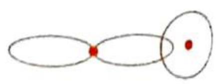
- (a) sp^3
- (b) sp^2
- (c) sp
- (d) dsp^2

5 Which of the following figures represents the overlapping of the orbitals to form π bond ?


(a)


(b)


(c)


(d)

6 According to the overlapped orbitals concept :
What is the total number of the atomic orbitals which overlap with each other to form N_2 molecule ?

(a) 2
(b) 3
(c) 5
(d) 6

7 In sp^2 hybridization, the arrangement of the electron pairs in space is ....

(a) linear.
(b) planar triangle.
(c) tetrahedral.
(d) angular.

8 What is the value of the angle between each two hybrid orbitals in the central atom of BF_3 molecule ?

(a) 90°
(b) 109.5°
(c) 120°
(d) 180°

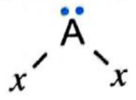
9 The covalent double bond between the two carbon atoms in the molecule of one of the organic hydrocarbons is formed of a sigma bond and a pi bond.
Which of the following represents the overlapped orbitals to form these bonds ?

Choices	σ bond	π bond
(a)	sp^2 - sp^2	p_z - p_z
(b)	sp^2 - sp^2	sp^2 - sp^2
(c)	sp^3 - sp^3	p_z - p_z
(d)	sp^3 - sp^3	sp^2 - sp^2

10 Which of the following two molecules are similar in the hybridization type in the central atom ?

(a) H_2O , SO_2
(b) CO_2 , SO_2
(c) SO_2 , SO_3
(d) NH_3 , SO_3

11 What is the type of the hybridization in the central atom in each of the two opposite compounds (1) and (2) ?


Compound (1)


Compound (2)

Choices	Compound (1)	Compound (2)
(a)	sp^2	sp^3
(b)	sp^2	sp^2
(c)	sp	sp^2
(d)	sp	sp^3

12 What is the change in the value of the angle between the hybrid orbitals when the hybridization changes from sp^3 to sp^2 then to sp ?

(a) Decreases.

(b) Does not change.

(c) Increases.

(d) Decreases then increases.

13 What is the type of the hybridization of carbon atom in CO_2 molecule ?

(a) sp

(b) sp^2

(c) sp^3

(d) dsp^3

14 What is the number of sigma bonds in the opposite compound ?

$$CH_2=CH-CH_2-\overset{\overset{O}{\|}}{C}-O-CH_2-CH=CH_2$$

(a) 15

(b) 17

(c) 18

(d) 21

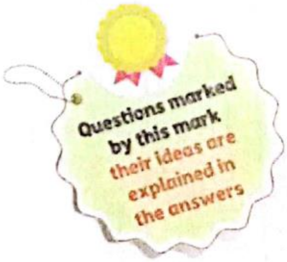
15 Which of the following choices represents the numbers of bonds in the molecule of $H_2C = C = CH_2$?

Choices	Number of sigma bonds	Number of pi bonds
(a)	4	2
(b)	6	4
(c)	2	6
(d)	6	2

16 Which of the following choices represents the types of the bonds in oxygen molecule, nitrogen molecule and hydrogen molecule ?

Choices	Oxygen molecule	Nitrogen molecule	Hydrogen molecule
(a)	1 sigma bond and 1 pi bond	1 sigma bond and 1 pi bond	1 sigma bond
(b)	1 sigma bond and 1 pi bond	1 sigma bond and 2 pi bonds	1 sigma bond
(c)	2 sigma bonds and 1 pi bond	1 sigma bond and 2 pi bonds	1 pi bond
(d)	2 sigma bonds and 1 pi bond	2 sigma bonds and 1 pi bond	1 pi bond

17 What is the sum of numbers of sigma bonds and pi bonds in one molecule of HCCCCCN ?



(a) 6
(b) 9
(c) 10
(d) 12

18 Which of the following molecules its atom becomes excited before the occurrence of the hybridization in it ?

(a) N_2
(b) NH_3
(c) H_2
(d) $CHCl_3$

Coordinate bond

19 On dissolving HCl gas in water, a bond is formed between positive hydrogen ion and water molecule, its type is ....

(a) covalent.

(b) ionic.

(c) hydrogen.

(d) coordinate.

20 Each of the following compounds can form a coordinate bond, except ....

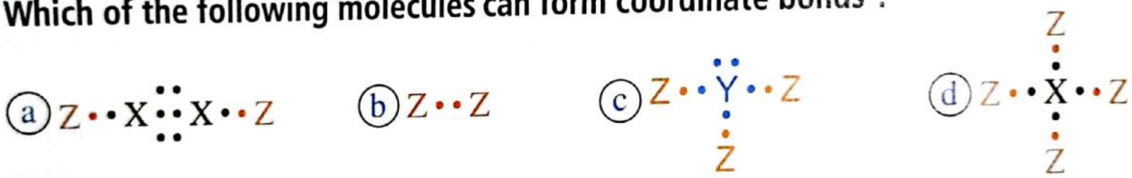
(a) PH_3

(b) HCl

(c) NH_3

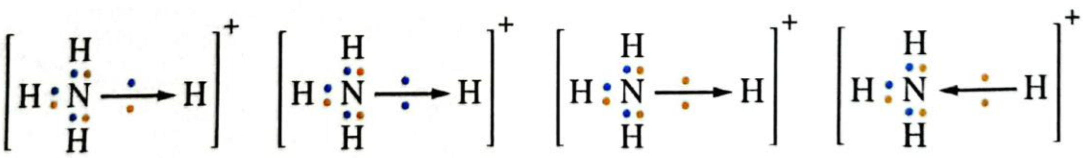
(d) H_2O

21 Which of the following molecules can form coordinate bonds ?



22 Which of the following choices represents the correct bonding in ammonium ion $(NH_4)^+$?

• N electron
• H electron



(a) (b) (c) (d)

Hydrogen bond

1 Hydrogen bonds are found between the molecules of each of the following compounds, except ....

(a) HF

(b) NH_3

(c) HCl

(d) H_2O

2 Pure water contains ....

(a) hydrogen bonds only.

(b) ionic bonds only.

(c) covalent bonds only.

(d) both covalent and hydrogen bonds.

3 What are the bonds which are found in ethanol CH_3CH_2OH ?

Choices	Single covalent bonds	Double covalent bonds	Hydrogen bonds
(a)	✓	✓	✗
(b)	✓	✗	✓
(c)	✗	✓	✓
(d)	✓	✓	✓

4 The ratio between the number of the covalent bonds to the number of hydrogen bonds in a sample of water is ....

(a) = 1

(b) < 1

(c) > 1

(d) = 3

5 A sample of pure water at room temperature contains :

- (x) mol of hydrogen bonds.
- (y) mol of covalent bonds.

What is the change in the numbers of these bonds which occurs upon heating this sample of water to 100°C under normal atmospheric pressure ?

Choices	Number of moles of hydrogen bonds	Number of moles of covalent bonds
(a)	Does not change	Does not change
(b)	Becomes less than (x) mol	Becomes less than (y) mol
(c)	Becomes less than (x) mol	Does not change
(d)	Becomes more than (x) mol	Becomes more than (y) mol

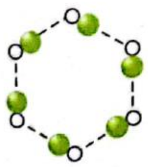
6 Three students assumed three factors which affect the strength of hydrogen bond :

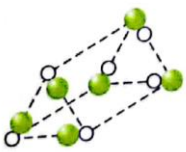
- Factor (1) : The angle between the hydrogen bond and the polar bond in the same molecule.
- Factor (2) : The number of bond pairs of electrons in the central atom.
- Factor (3) : The difference in electronegativity between hydrogen atom and the other atom which binds to it.

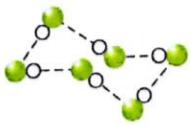
Which of these factors are correct ?

(a) (1) and (2).
(b) (1) and (3).
(c) (2) and (3).
(d) (1) , (2) and (3).

7 Which of the following figures represents 6 molecules of HF binded together with hydrogen bonds ?


(1)


(2)


(3)


(4)

(a) (1) , (2).
(b) (2) , (3).
(c) (3) , (4).
(d) (1) , (3).

The metallic bond

8 The elements $_{12}Mg$, $_{14}Si$, $_{16}S$ and $_{17}Cl$ are located in the third period in the periodic table.

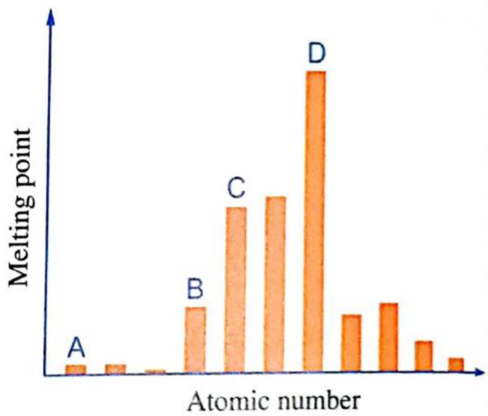
Which of the following represents the correct graduation in the melting points of these elements ?

Choices	Lowest melting point ⟶ Highest melting point			
(a)	Cl	S	Mg	Si
(b)	Cl	S	Si	Mg
(c)	Mg	Si	S	Cl
(d)	Si	Mg	S	Cl

Questions marked by this mark their ideas are explained in the answers

9 The opposite graphical figure shows the melting points of different elements, among which is sodium $_{11}Na$

Which of the illustrated letters refers to sodium element ?



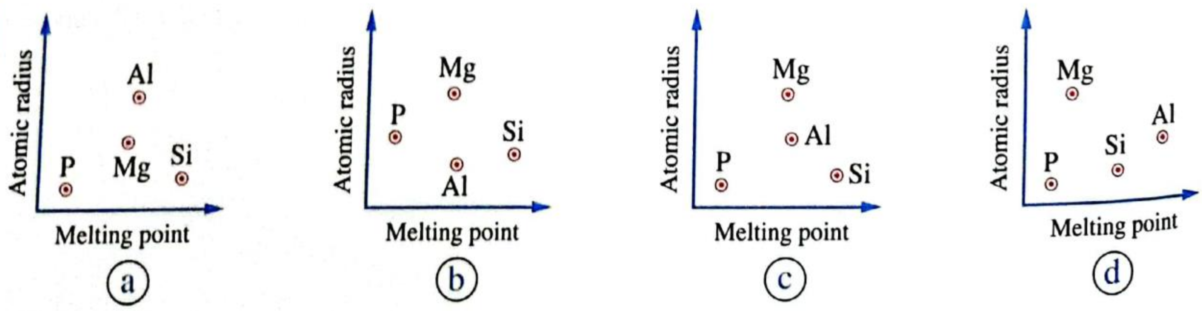
(a) A

(b) B

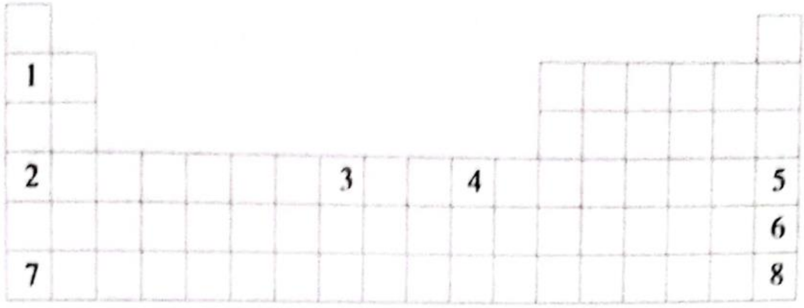
(c) C

(d) D

10 Which of the following graphical figures represents the relation between the atomic radii of the elements $_{12}Mg$, $_{13}Al$, $_{14}Si$, $_{15}P$ and their melting points ?



11 The following figure represents a section in the periodic table.



Which of the following pairs of elements has hardness which equals 0.5 on Mohs' scale ?

(a) 1 , 2

(b) 3 , 4

(c) 5 , 6

(d) 7 , 8

Chapter 4

The main group elements of the periodic table

1- S – Block elements : elements of group I Alkali metals .
2- P – Block elements : elements of group V.A

First : elements of S – Block

Elements of (1A) group :

Elements of (1A) group are considered as alkali metals because their oxides dissolve in water easily forming strong Alkalis .

1- Lithium → Li → no using
2- Sodium → Na → Rock salt (NaCl)
3- Potassium → K → in sea water KCl and carnallite ($KClMgCl_2.6\ H_2O$) .
4- Rubidium → Rb → no using
5- Caesium → Cs → no using
6- Franciuim → Fr → Radioactive element it is produced from diseintigration of actinium

$${}_{89}Ac^{227} \longrightarrow {}_{87}Fr^{223} + {}_{2}He^{4}$$

General properties of elements of group 1A

1- Every element consists of one electron in the outer most energy level they are characterized by :

A- Every element lies in the beginning of new period .

B- Oxidation number in their compounds is equal (1+).

C- They are chemically very active due to the presence of one electron in the outer mast energy level which can by easily lost and they have very low ionization potential .

D- The first ionization energy low while second ionization energy is high because in the first ionization energy it is easy to lose the valencey electron but the second ionization energy result from the breaking up of a completely filled shell .

2- Most of their compounds are ionic: -

They can lose the electrons from their outer most energy level easily to form positive ions which have the same electronic structure of noble gas which preceds it .

3- They are very strong reducing agent because they have a large atomic radius (or volume) and small ionization energy so they lose the electrons from their outer most energy level easily .

4- They are most (soft) metals with low melting and boiling points due to the decreasing in the strength of the metalic bond between atoms since they have only one electron in the outer most energy level .

5- They have a large atomic radius because each element occupied the begining of its period .

6- **Elements of group (1A) are considered of the highest electropositive metals because they can easily lose the valency electron .**

7- Potassium and Caesium are used in photoelectric calls because the atoms of these elements have a large atomic radius and small ionization energy so when they are exposed to light they lose the electrons from their outer most energy level easily .

6- They have characteristic colours when the atom gains an amount of energy which is sufficient to transfer electrons to higher energy levels they give a characteristic colours : dry test

Element	Colour
Lithium	Crimson
Sodium	Golden yellow
Potassium	Pale violet
Calcium	Bluish violet

7- They are kept under liquid hydrocarbons .

Sodium is kept under kerosine because it is a very active metal which can react with air and water so it is stored under kerosine .

8- Action of atmospheric air :

All elements lose their metalic luster because they reacts easily with air to form metal oxide .

* Reaction with nitrogen of air to form (give) lithium nitride .

$$6Li + N_2 \longrightarrow 2Li_3N$$

G.R.F :

Lithium nitride is used a fertilizer ?

This is Because lithium nitride decomposes when the soil is irrigated giving ammonia (fertilizer) .

$$Li_3N + 3H_2O \longrightarrow NH_3 + 3LiOH$$

9- **Reaction with water**

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2 + E$$

Sodium reacts with water forming sodium hydroxide and large amount of energy which is enough to cause the burning of hydrogen evolves with an explosion so sodium fires are not extinguished by water .

10- Reaction with oxygen :

$$4Li + O_2 \longrightarrow 2Li_2O$$

$$2Na + O_2 \longrightarrow Na_2O_2$$

$$2K + O_2 \longrightarrow 2KO_2$$

Potassium super oxide is used in submarines and aeroplanes in closed atmospheres because it reacts with exhaled carbon dioxide giving oxygen required for breathing :

$$4KO_2 + 2CO_2 \xrightarrow[\text{Cat.}]{Cucl_2} 2K_2CO_3 + O_2$$

11- Reaction with acides

$$2Na + 2HCl \longrightarrow 2NaCl + H_2$$

12- Reaction with hydrogen (to form hydrides)

$2Li + H_2 \longrightarrow 2LiH$

$2Na + H_2 \longrightarrow 2NaH$

$NaH \xrightarrow{\text{Electrolysis}} Na^+ + H^-$

Go towards cathode ← (Na^+) (H^-) → Go towards anode

N.B : Hydrides are ionic compounds because they produced from the reaction of element with hydrogen such as NaH , LiH .

13- Reaction with halogens :

All elements of group 1A are reacts with halogens forming very stable ionic halides .

$2Na + Cl_2 \longrightarrow 2NaCl$

$2K + Br_2 \longrightarrow 2KBr$

14- Reaction with other non – metal :

$2Na + S \longrightarrow Na_2S$ (Sodium sulphide)

$3K + P \longrightarrow K_3P$ (Potassium phosphate)

15- Action of heat on metal carbonates :

All alkali metals carbonates do not decompose when heated except Lithium carbonate .

$Li_2CO_3 \xrightarrow{\text{Heat}} Li_2O + CO_2$

16- Action of heat on metals nitrates :

They decompose partially giving metal nitrite and oxygen

$2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$

Sodium nitrate is not used in the manufacture of bombs because a great explosion happens when potassium nitrate decomposes by heat

$2KNO_3 \xrightarrow{\Delta} 2KNO_2 + O_2$

Extraction of metals

Alkali metals are not found in elemental state in nature because these metals are easily to losing their valence electron and oxidized in atmospheric air forming the oxide .

Elements of group (1-A) are extracted from their ores by electrolysis because they strongest reducing agent and can not be reduced from their ores by any reducing agents other than electrolysis .

Anhydride : Compounds which dissolve in water giving acid or alkali .

Commonly used sodium compounds

sodium hydroxide NaOH

a) **preparation in industry :**

by the electrolysis of sodium chloride solution

b)properties:

1- a white hygroscopic solid compound

2- it has a corrosive effect on skin

3- it dissolves easily in water forming an alkaline solution through an exothermic dissolution

1-it react with acids forming the sodium salt of the acid and water

$$NaOH + HCL \longrightarrow NaCL + H_2O$$

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

Uses :

1- NaOH used in many industries as : Soap , synthetic silk and paper

2- it used in purify petrol

3- detection of basic radicals (cations):-

detection of of copper II (Cu^{++})

salt solution + NaOH it gives a blue p.p.t turns black by heating

$$CuSO_4 + 2NaOH \longrightarrow Cu(OH)_2 + Na_2SO_4$$

$$Na_2SO_4 \longrightarrow CuO + H_2O$$

Detection of aluminium AL^{3+}

Salt solution + NaOH gives a white p.p.t dissolves in excess of NaOH

$$AlCl_3 + 3NaOH \longrightarrow 3NaCl + Al(OH)_3$$

$$Al(OH)_3 + NaOH \longrightarrow NaALO_2 + H_2O$$

1- sodium carbonate Na_2CO_3

the hydrated salt $Na_2CO_3.10H_2O$ is known as washing soda

a) preparation :

1- in laboratory : by passing CO_2 gas through a hot solution of NaOH , the solution is left to cool , white crystal of Na2CO3 are separated
2- in industry : (Solvay method)

$$NH_3 + CO_2 + Nacl + H_2O \longrightarrow NaHCO_3 + NH_4Cl$$

$$2NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O$$

Properties:

1- white powder , easily dissolves in water . its solution has an alkaline effect
2- it is not affected by heat i.e. it melts without decomposition
3- it react with acid , and CO2 evolves

$$Na_2CO_3 + 2HCl \longrightarrow 2Na_2CO_3 + CO_2 + H_2O$$

Uses :

1- paper industry
2- water softening
3- textile industry
4- manufacture of glass

Elements of group (5A)

Nitrogen N_7 : non – metal – diatomic – gas in atmospheric air 80% .

Phosphor P_{15} : non – metal – Calcium phosphate ($Ca_3(PO_4)_2$) Apatite $CaF_2Ca_3(PO_4)_2$ (4 atom) .

Arsenic As_{33} : metalloid – Arsenic sulphide As_2S_3 – vapour (4atom As_4)

Antimony Sb_{51} : metalloid–Antimony sulphude Sb_2S_3 – vapour atoms Sb_4

Bismuth Bi_{83} : metal forming a crystal lattice – weak to conduct electricity – vapour (2atom)

General properties

1- **Oxidation number** : Elements of group [5 – A] have several oxidation numbers because they gain electrons from 1 to 3 through covalent sharing or electrons from 1 to 5 electron and reach to the stability state .

2- **With oxygen** : All elements of this group form oxides are acidic (decreases with increasing the atomic number) such as N_2O_3, N_2O_5, P_2O_3, P_2O_5 while other are amphoteric Sb_2O_3 or Bi_2O_3 or basic (increases with increasing the atomic number) Bi_2O_3 .

3- **With hydrogen** : Most of elements of this group reacts with hydrogen to form hydrides such as NH_3 , PH_3 , phosphene , Arsine AsH_3

These compounds (NH_3- PH_3) can form coordinate bonds due to presence of pair of electrons in valence shell so it can give this electrons to the outer atoms or ions to form coordinate bond

$NH_3 + H^+ \longrightarrow NH_4$, $PH_3 + H^+ \longrightarrow PH_4$

These compounds are basic because atom of element has one pair of electrons donated to positive proton of hydrogen which is found in the molecule of water therefore the negative hydroxyl group separated from molecule of water .

$NH_3 + H^+OH^- \longrightarrow NH_4^+ \quad OH^-$

- The polarity of hydrogen compounds in this group decreases with increasing atomic number .

- The thermally stability and the solubility in water are decreases with increasing the atomic in this group (NH_4^+) is more polarity than (PH_4^+) is more polarity than (AsH_4^+)

Allotropy

It is the presence of the element in more than one form having the same chemical properties but different physical properties .
Both nitrogen (gas) and bismuth (metal) have not allotropic .

Forms :

Solid non - metal	Allotropic forms
Phosphorus	white – red – violet.
Arsenic	black – grey – yellow.
Antimony	yellow – black.

Nitrogen N_2

Properties of nitrogen

1- Reaction of nitrogen with hydrogen

$$N_2 + 3H_2 \xrightarrow[\text{spark}]{\text{Electric}} 2NH_3$$

2- Reaction of nitrogen with oxygen

$$N_2 + O_2 \xrightarrow[\text{arc.}]{\text{Electric}} 2NO$$

The colour of nitric oxide (colourless) turns brown when it is exposed to atmospheric because nitric oxide is oxidized to form nitrogen dioxide when it exposed to air .

$$2NO + N_2 \longrightarrow 2NO_2$$

3- Reaction of nitrogen with metals

$$3M + N_2 \xrightarrow{\Delta} Mg_3N_2$$

magnesium nitride

$$Mg_3N_2 + 6H_2O \longrightarrow 2NH_3 + 3Mg(OH)_2$$

4- Reaction of nitrogen with calcium carbide ($CaCN_2$) to form calcium cyanamide ($CaCN_2$) is used as agricultural fertilizer because it reacts with water irrigating to from ammonia gas fertilizer .

$$CaC_2 + N_2 \longrightarrow CaCN_2 + C$$

$$CaCN_2 + 3H_2O \longrightarrow CaCO_3 + 2NH_3$$

Important nitrogen compounds

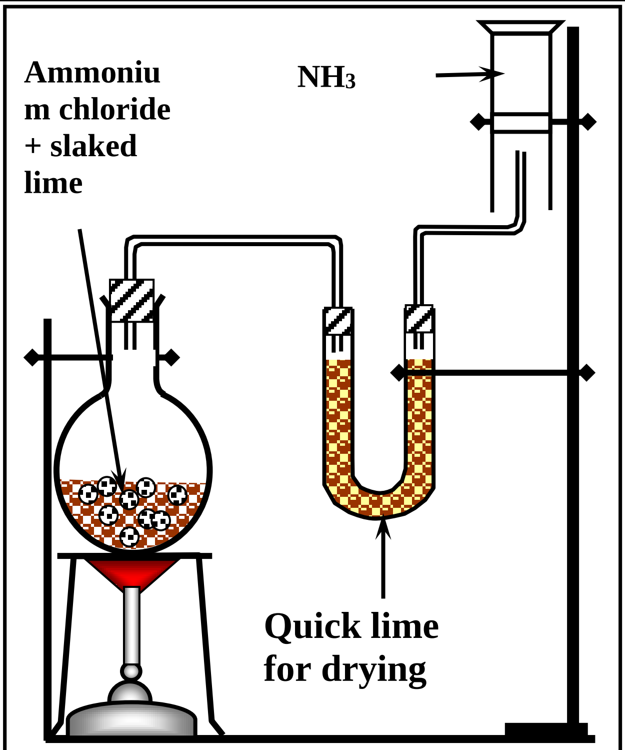
1- Ammonia gas (NH_3)

Preparation ammonia gas in lab

By heating a mixture of ammonium chloride and salked lime (Ca $(OH)_2$)

$$2NH_4Cl + Ca(OH)_2 \longrightarrow CaCl_2 + 2NH_4OH$$

$$2NH_4OH \xrightarrow{Heat} 2NH_3 + 2H_2O$$



Preparation og ammonia in lab

Ammonia gas is dried by passing it in quick lime (CaO) because quick lime dose not react with ammonia gas conc. H_2SO_4 in not used for dring ammonia gas because it reacts with acid forming $(NH_4)_2SO_4$ due to the basic property of ammonia .

Ammonia gas is collected by down – word displacement of air because it is lighter than air or density of NH_3 is less than air .

Properties of NH_3 gas

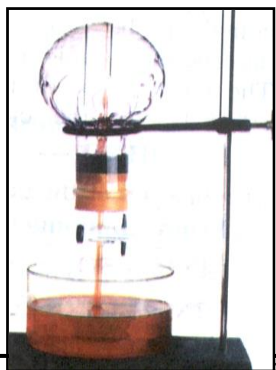
1- It is colourless and pungent smell .

2- It is easily soluble in water to from NH_4OH which turns the red litmus solution into blue .

$$NH_3 + H_2O \longrightarrow NH_4OH$$

***Experiment to prove that NH_3 gas is soluble in water and its solution has alkaline effect .**

1- **Setup the apparatus as show in figure the lower bottle contains litmus**



(The fountain experiment)

G.R.F : Ammonia is considered anhydride base ?

Preparation of ammonia gas in industry (Haber's method)

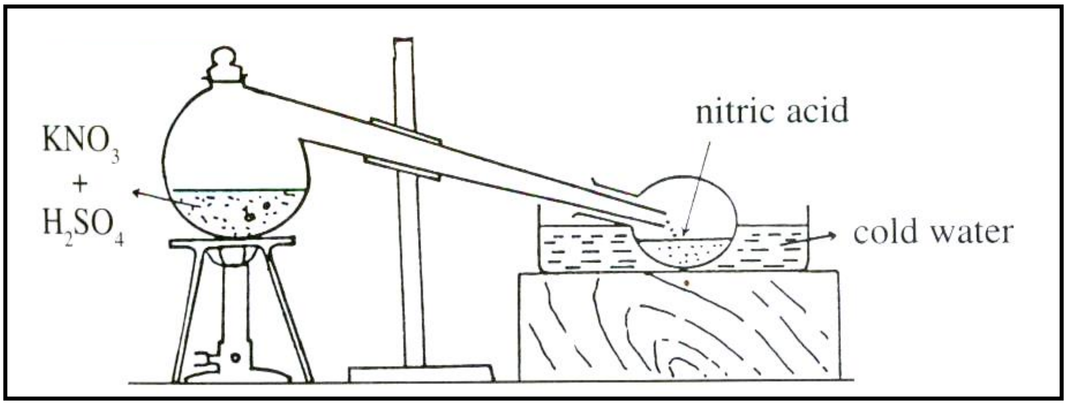
From nitrogen and hydrogen in presence of catalyst (iron) at 500^{o}C under 200 atmospheric pressure .

$N_2 + 3H_2 \longrightarrow 2NH_3$

2- Nitric acid HNO_3

1- preparation of nitric acid in lab

$2KNO_3 + H_2SO_4 \xrightarrow[\text{Conc.}]{\text{Heat}} K_2SO_4 + 2HNO_3$



The apparatus for preparation of nitric acid does not contain rubber stopper because the vapours of nitric acid damage the organic materials as rubber .

The temperature of exp. dose not exceed more than 100^{o}C because the acid is decomposed thermally .

2- Preparation of the acid in industry

Properties of acid :

1- **Action of heat** :

It decomposed by heat giving nitrogen dioxide (NO_2), oxygen and water

$4HNO_3 \longrightarrow 4NO_2 + O_2 + 2H_2O$

2- Nitric acid is an oxidizing agent because it is reduced in to different product depends on :

- **a- The activity of reducing agent (the metal) .**
- **b- The presence of some impurities in the metal .**
- **c- Concentration of the acid .**
- **d- Temperature of reaction :**

- <u>Metals above hydrogen .</u>

$$2Fe + 8HNO_3 \xrightarrow{Dil} 2Fe(NO_3)_3 + 4H_2O + 2NO$$

<u>- Metals below hydrogen in chemical series .</u>

$$3Cu + 8HNO_3 \xrightarrow{Dil} 3Cu(NO_3)_2 + 4H_2O + 2NO$$

$$Cu + 4HNO_3 \xrightarrow{Conc} Cu(NO_3)_2 + 2H_2O + 2NO_2$$

Copper reacts with nitric acid although it is below hydrogen in the electro chemical series because the acid reacts with copper as oxidizing agent i.e. it oxidize the copper to copper oxide which reacts with acid .

The above reaction is used to differentiate between dil. and canc. HNO_3 :

Experiment	Dilute HNO_3	Conc. HNO_3
1- put a piece of copper to each of them .	**Nitric oxide gas colourless is formed that turns in to nitrogen dioxide gas .** $Cu + HNO_3 \xrightarrow{Dil} Cu(NO_3) + 2NO + 2H_2O$	**Nitrogen dioxide gas (reddish brown fumes) are formed .** $Cu + 4HNO_3 \xrightarrow{Conc} Cu(NO_3)_2 + 2NO_2 + 2H_2O$

<u>The passivating effect</u> : Some metals (such as Fe – er – Al) are not affected by the concentrated nitric acid (HNO_3) due to the formation of layer of the metal oxide and this layer is non porous so it protects the metal from further reaction .

Economic importance of 5th group elements

Nitrogen : The manufacture of Ammonia – nitric acid – nitrogenous fertilizers .

Phosphorus : The manufacture of matches , rat- poison , several military industries , phosphorus fertilizers , many alloys such as phosphorus bronze (Cu + Sn + P) and incendiary bombs .

Antimony : It is used with lead in accumulators antimony sulphide (Sb_2O_3) is used for dying .

Bismuth : Alloys of bismuth , lead cadmium and tin are characteriesed by their low melting point .

Questions

Abundance of alkali metals in nature

1 Each of the following represents the electron configuration of an alkali metal, <u>except</u> ....

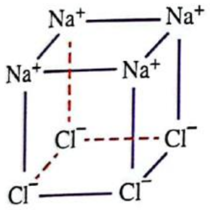
(a) 2 , 1

(b) [Ne] , $4s^1$

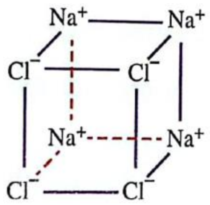
(c) [Ar] , $4s^2$, $3d^{10}$, $4p^6$, $5s^1$

(d) [Xe] , $6s^1$

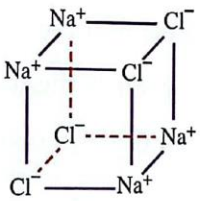
2 Which of the following represents a crystal of rock salt ?



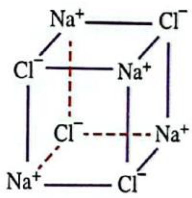
(a)



(b)



(c)



(d)

3 The molecular formula of carnallite is ....

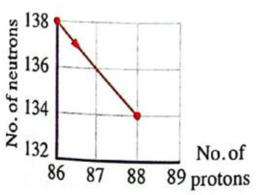
(a) $ClH_{12}KMgO$

(b) $Cl_3H_{12}KMgO_6$

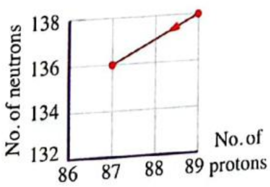
(c) Cl_3H_2KMgO

(d) $KCl.MgCl.6H_2O$

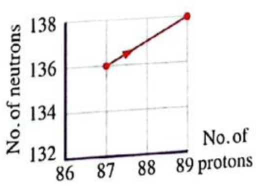
4 Which of the following graphical figures represents the synthesis of francium element from actinium element ?



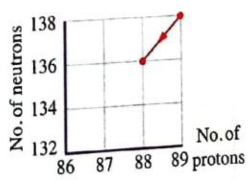
(a)



(b)



(c)



(d)

General properties of alkali metals

5 **The chemically active metal ....**

(a) loses its valence electrons easily.

(b) forms unstable compounds.

(c) burns in air easily forming an acidic oxide.

(d) forms an oxide which is easily reduced by carbon.

6 **It is not normal for sodium to exist in the oxidation state +2, because of its ....**

(a) high first ionization potential.

(b) high second ionization potential.

(c) large ionic radius.

(d) high electronegativity.

7 **The similarity of the chemical properties of the alkali metals is attributed to that ....**

(a) they all have the same electron configuration of the nearest noble gas.

(b) the valence electron of each of them has the same four quantum numbers.

(c) the valence electron of each of them has the same energy.

(d) the valence shell of each of them contains one electron.

8 **Which of the following elements loses its valence electron most easily ?**

(a) Li

(b) Na

(c) K

(d) Cs

9 **By comparing the properties of the alkali metals, it is concluded that francium ....**

(a) has the lightest atomic mass.

(b) has the largest atomic size.

(c) has lower ability to be ionized.

(d) is more stable.

10 **Each of the following statements is correct, except ....**

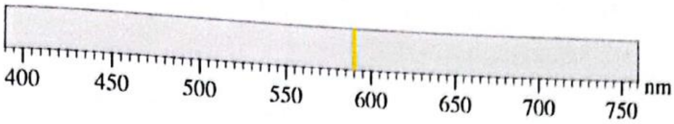
(a) Alkali metals are similar in their electronegativities.

(b) Lithium properties differ from some of magnesium properties.

(c) Photoelectric phenomenon of alkali metals increases by increasing the atomic number.

(d) Alkali metals are very strong reducing agents.

11 The following figure represents the wavelength of the colour of the characteristic visible line spectrum of a metal atoms.



What is this metal ?

ⓐ Li
ⓑ Na
ⓒ K
ⓓ Cs

12 Metal (X) is used in manufacturing some of the high efficacy yellow light bulbs. Which of the following represents metal (X) ?

ⓐ It lies in the first period in the periodic table.
ⓑ Its density is higher than that of water.
ⓒ It reacts with water vigorously.
ⓓ It is being extracted from its chloride solution.

13 What is the correct classification of cesium oxide ?

ⓐ Very strong base.
ⓑ Weak base.
ⓒ Acidic oxide.
ⓓ Amphoteric oxide.



14 Which of these hydroxides is the most basic ?

ⓐ NaOH
ⓑ LiOH
ⓒ RbOH
ⓓ KOH

15 RbO_2 is ....

ⓐ a normal oxide.
ⓑ a peroxide.
ⓒ a superoxide.
ⓓ an acidic oxide.

16 All the following chemical formulas represent peroxides, except ....

(a) Na_2O_2

(b) H_2O_2

(c) Fe_2O_3

(d) BaO_2

17 Upon using 100 mol of KO_2 to purify the air in a submarine, (1) of CO_2 gas are consumed, and (2) of O_2 gas are produced.

What are the numbers of the moles (1) and (2) ?

Choices	The number of the moles (1)	The number of the moles (2)
(a)	50 mol	50 mol
(b)	50 mol	75 mol
(c)	75 mol	50 mol
(d)	75 mol	75 mol

18 Which of the following sodium halides has the highest melting point ?

(a) NaF

(b) NaCl

(c) NaBr

(d) NaI

19 Which of the following alkali metals carbonates is the least stable ?

(a) Li_2CO_3

(b) Na_2CO_3

(c) K_2CO_3

(d) Cs_2CO_3

20 Each of the following represents the alkali metal (X) whose electrons are distributed in two energy levels, except that ....

(a) its carbonate decomposes thermally.

(b) it has the least ionization potential in its period.

(c) it dissolves in water forming an alkaline solution.

(d) it floats over the surface of kerosene.

21 All the following reactions occur vigorously, except ....

(a) the decomposition reaction of potassium nitrate.
(b) the reaction of alkali metal with halogen.
(c) the reaction of alkali metal with water.
(d) the reaction of alkali metal with nitrogen.

22 Sodium carbonate is similar to lithium carbonate in ....

(a) the effect of the strong heat on both of them.
(b) the gas produced from their reactions with the acids.
(c) their melting points.
(d) the colour formed during the dry test.

Extraction of alkali metals from their ores

23 What are the oxidizing agent and the reducing agent in the electrolysis of sodium chloride melt ?

Choices	Oxidizing agent	Reducing agent
(a)	Cl	Na
(b)	Cl^-	Na^+
(c)	Na^+	Cl^-
(d)	Na	Cl

Sodium hydroxide

24 What happens when a sample of solid sodium hydroxide flakes is left in air for hours ?

(a) It does not change.
(b) It becomes harder.
(c) Its mass increases.
(d) Its mass decreases.

25 In the two following reactions :

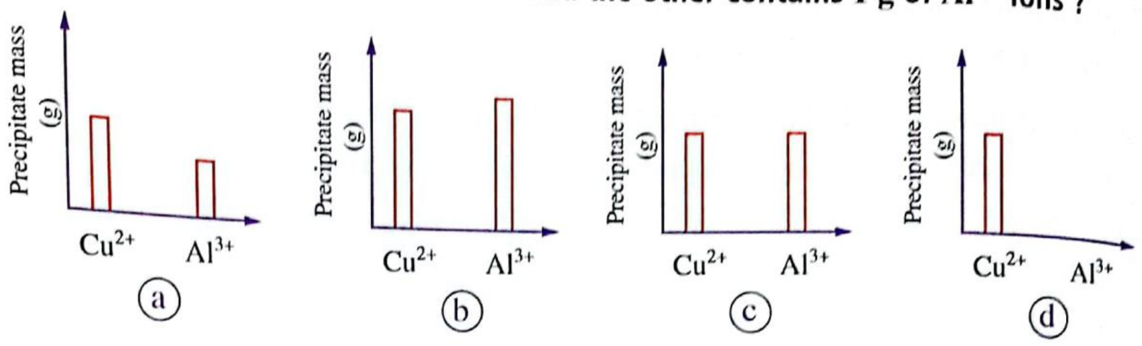
- $NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$
- $2NaOH_{(aq)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

All the following are correct, except that ....

(a) they both are neutralization reactions.
(b) they both form sodium salts.
(c) the number of lone pairs of electrons in S atom in H_2SO_4 is higher than their number in Cl atom in HCl
(d) they both are represented by the net ionic equation : $H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$

...Regular Groups in the Periodic Table .

26 Which of the following graphical figures represents the formed masses of the precipitates when excess NaOH solution is added to two different solutions, one of them contains 1 g of Cu^{2+} ions and the other contains 1 g of Al^{3+} ions ?



Sodium carbonate

27 When sodium carbonate reacts with the substance (X) which is dissolved in water, CO_2 gas evolves.

What is the type of the substance (X) ?

- (a) Basic oxide.
- (b) Metal oxide.
- (c) Ammonia.
- (d) Nonmetal oxide.

Questions marked by this mark their ideas are explained in the answers

28 In the following unbalanced equations :

- $Na_2CO_{3(s)} + X \longrightarrow Y + H_2O_{(l)} + CO_{2(g)}$
- $NaOH_{(aq)} + X \longrightarrow Y + H_2O_{(l)}$

What are the types of the substances (X) and (Y) ?

Choices	(X)	(Y)
(a)	Salt	Acid
(b)	Acid	Salt
(c)	Base	Salt
(d)	Acid	Base

Abundance of the elements of group (5A) in nature

1 What is the electron configuration of the elements of group (15) ?

ⓐ ns^2 , np^3

ⓑ ns^1 , np^4

ⓒ $(n - 1)d^9$, ns^2 , np^3

ⓓ $(n - 1)d^1$, ns^2 , np^3

2 Arsenic $_{33}As$ and antimony $_{51}Sb$ are similar in that ....

ⓐ they are both of the elements of the fourth period.

ⓑ they both have the same number of electrons in the valence shell.

ⓒ they both can conduct electricity better than the metals.

ⓓ they are both metals.

3 What is the number of Ca^{2+} , PO_4^{3-} ions required for forming 10 formula units of calcium phosphate ?

Choices	Number of Ca^{2+} ions	Number of PO_4^{3-} ions
ⓐ	20	30
ⓑ	20	20
ⓒ	30	30
ⓓ	30	20

General properties of group (5A) elements

4 Some of the elements of the groups (4A) and (5A) have several allotropic forms, such as ....

ⓐ C , N

ⓑ C , P

ⓒ Bi , As

ⓓ Pb , Sb

5 All the following is correct about nitrogen, except ....

ⓐ its atomic size is the smallest compared to other group (5A) elements.

ⓑ its electronegativity is the highest among group (5A) elements.

ⓒ it can form bonds through the unpaired electrons in its *d* sublevel.

ⓓ its ionization energy is the highest among group (5A) elements.

6 Element (M) can form the following compounds :

- MO_2
- M_2O_3
- MH_3
- HMO_3

In which of the following groups of the modern periodic table is element (M) located ?

ⓐ 1A

ⓑ 2A

ⓒ 5A

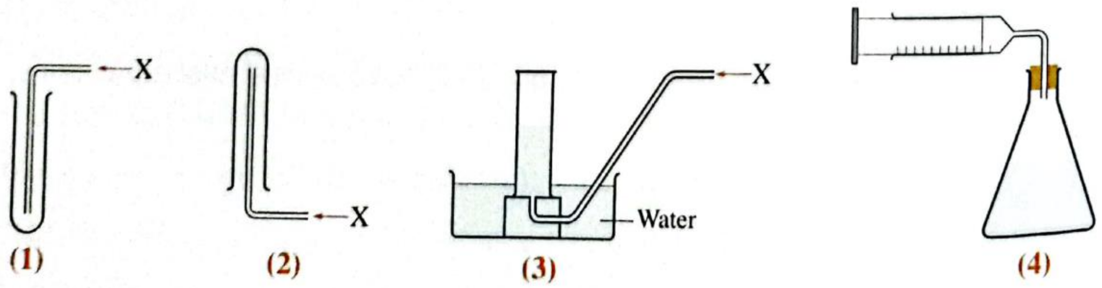
ⓓ 6A

7 Which of the following is the correct graduation in the stability of the hydrides of group (5A) elements ?

Choices	Least stable ⟶ Most stable			
ⓐ	NH_3	PH_3	AsH_3	SbH_3
ⓑ	SbH_3	AsH_3	PH_3	NH_3
ⓒ	NH_3	SbH_3	AsH_3	PH_3
ⓓ	AsH_3	SbH_3	NH_3	PH_3

Nitrogen gas

8 Nitrogen gas is lighter than air and sparingly soluble in water.
Which method(s) can not be used to collect nitrogen gas ?



ⓐ (1) , (4).

ⓑ (2) , (3).

ⓒ (1).

ⓓ (4).

9 **Why can not nitrogen gas react with magnesium except at high temperature ?**

(a) Due to the small atomic radius of nitrogen.

(b) Due to the high electronegativity of nitrogen.

(c) Because it is difficult to break the covalent bond between the two nitrogen atoms.

(d) Due to the stability of the electronic configuration of nitrogen.

10 **Oxidation number of nitrogen in the product of the reaction of magnesium with nitrogen gas is ....**

(a) +5 (b) +3

(c) –1 (d) –3

Ammonia gas

11 **When calcium hydroxide reacts with ammonium chloride, three compounds are produced How many of these products can their stereostructures be identified according to the number of the lone pairs and the bond pairs of electrons in the central atom ?**

(a) Zero (b) 1

(c) 2 (d) 3

12 **What can be concluded from the fountain experiment ?**

(a) Basicity of ammonia gas only.

(b) Polarity of ammonia gas only.

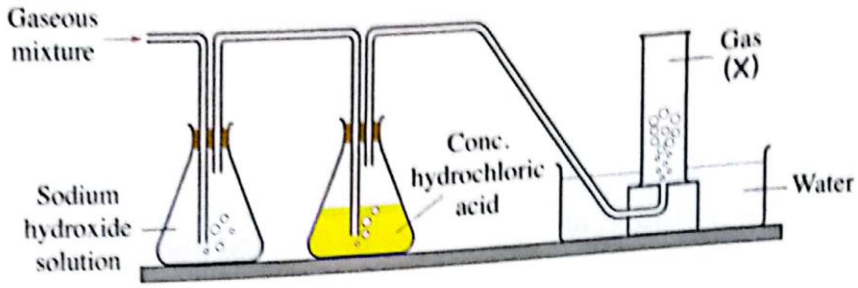
(c) The stereostructure of ammonia gas only.

(d) Basicity and polarity of ammonia gas.

13 **An impure sample of air contains high proportions of each of NH_3 and CO_2 What are the substances which air can be passed through to eliminate these gases ?**

Choices	Ammonia gas	Carbon dioxide gas
(a)	Water	Water
(b)	Calcium oxide	Conc. sulphuric acid
(c)	Conc. hydrochloric acid	Potassium hydroxide solution
(d)	Red hot copper	Sodium hydroxide solution

A mixture of NH_3 , N_2 and CO_2 gases is passed in the apparatus shown in the following figure.



Which of the following represents a property of the gas (X) ?

ⓐ It turns the colour of litmus solution to red when it is passed in it.

ⓑ It reacts with metals forming nitrides.

ⓒ It turns clear limewater turbid.

ⓓ It increases the glowing of a lit splint.

Questions marked by this mark their ideas are explained in the answers

5 Which of the following statements is correct ?

ⓐ Ammonium nitrate dissolves in water forming a neutral solution.

ⓑ Ammonium sulphate dissolves in water forming a basic solution.

ⓒ Ammonium nitrate dissolves in water forming an acidic solution.

ⓓ Ammonium phosphate is insoluble in water.

6 Adding the following substances to the soil affects its acidity, except ....

ⓐ ammonium nitrate.

ⓑ ammonium phosphate.

ⓒ ammonium sulphate.

ⓓ slaked lime.

7 Nitrate salts which are used as fertilizers cause the pollution of the rivers, because they ....

ⓐ are salts.

ⓑ are highly soluble in water.

ⓒ contain nitrogen.

ⓓ contain nitrate negative ion.

Nitric acid

18 **Which of the following represents dilute nitric acid ?**

ⓐ $H_{(aq)} + NO^{-}_{3(aq)}$

ⓑ $H^{+}_{(aq)} + NO^{-}_{3(aq)}$

ⓒ $H^{+}_{(aq)} + NO^{2-}_{3(aq)}$

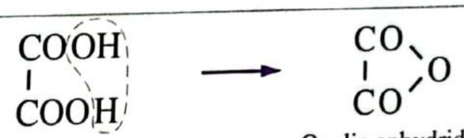
ⓓ $HNO_{3(l)}$

19 **What is the total number of moles of the gases and vapours produced from the reaction of 4 mol of potassium nitrate with 2 mol of concentrated sulphuric acid at 150°C ?**

ⓐ 2 mol ⓑ 3 mol

ⓒ 6 mol ⓓ 7 mol

20 **The opposite equation illustrates the derivation of oxalic anhydride from oxalic acid.**



Oxalic acid → Oxalic anhydride

What is the nitrogen oxide which is considered as the anhydride of nitric acid ?

ⓐ N_2O_5 ⓑ N_2O_4

ⓒ N_2O_3 ⓓ N_2O

21 **What is the number of moles of iron (III) nitrate which is produced from the reaction of 0.25 mol of iron with excess of hot dilute nitric acid ?**

ⓐ 0.25 mol ⓑ 0.5 mol

ⓒ 1 mol ⓓ 3 mol

22 **What is the difference between NO gas and NO_2 gas ?**

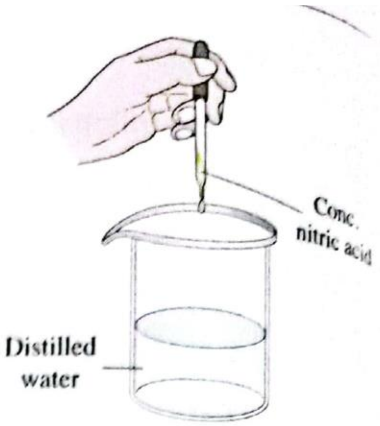
ⓐ NO gas is colourless, while NO_2 gas is green.

ⓑ Oxidation number of nitrogen in NO is a negative value, while in NO_2 is a positive value.

ⓒ When NO gas is oxidized, it is converted into NO_2 gas.

ⓓ NO gas is produced from the reaction of Cu with conc. nitric acid, while NO_2 gas is produced from the reaction of Cu with dil. nitric acid.

23 Some copper filings were added to the beaker illustrated in the opposite figure with heating. Which of the following nitrogen oxides is produced from this reaction ?



(a) N_2O_5
(b) N_2O_4
(c) NO_2
(d) NO

24 What is the change in the oxidation number of nitrogen that occurs when copper reacts with hot dilute nitric acid ?

(a) $+5 \longrightarrow +2$
(b) $-5 \longrightarrow -2$
(c) $+4 \longrightarrow +3$
(d) $-3 \longrightarrow +4$

25 Silver element reacts with dilute nitric acid in the same manner of copper reaction with it.
Which of the following equations represents the reaction of silver with dilute nitric acid ?

(a) $2Ag_{(s)} + 2HNO_{3(aq)} \xrightarrow[dil]{\Delta} 2AgNO_{3(aq)} + H_{2(g)}$
(b) $3Ag_{(s)} + 8HNO_{3(aq)} \xrightarrow[dil]{\Delta} 3AgNO_{3(aq)} + 2NO_{(g)} + 4H_2O_{(l)}$
(c) $Ag_{(s)} + 4HNO_{3(aq)} \xrightarrow[dil]{\Delta} AgNO_{3(aq)} + 2H_2O_{(l)} + 2NO_{2(g)}$
(d) $3Ag_{(s)} + 4HNO_{3(aq)} \xrightarrow[dil]{\Delta} 3AgNO_{3(aq)} + NO_{(g)} + 2H_2O_{(l)}$

26 What is the oxide which reacts with ferrous sulphate forming a dark brown compound ?

(a) N_2O_5
(b) NO
(c) NO_2
(d) N_2O_3

27 On performing the dry detection for the salt (X), the non-illuminant region of bunsen flame acquired a pale violet colour, and on adding the solution of the salt (X) to a freshly prepared concentrated solution of iron (II) sulphate with adding drops of conc. sulphuric acid carefully on the inner walls of the test tube, a brown ring was formed at the interface between the acid and the reaction solutions.
What is the chemical formula of the salt (X) ?

(a) $NaNO_2$

(b) KNO_3

(c) KNO_2

(d) $NaNO_3$

28 What is the anion which is detected by potassium permanganate solution acidified with conc. sulphuric acid ?

(a) SO_4^{2-}

(b) CO_3^{2-}

(c) NO_2^-

(d) NO_3^-

29 The colour of potassium permanganate solution acidified with sulphuric acid disappears when it is added to potassium nitrite solution as a result of ....

(a) its reduction.

(b) its oxidation.

(c) its neutralization.

(d) its passivity.

30 Which of the following data clarifies the drivers preference to fill their cars tyres with nitrogen instead of oxygen ?

(a) Atomic number of nitrogen is 7 and that of oxygen is 8

(b) Molar mass of nitrogen molecule is 28 g/mol and that of oxygen molecule is 32 g/mol

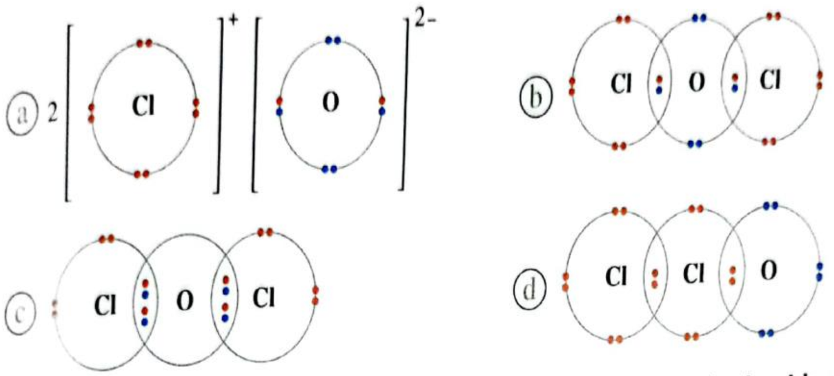
(c) Boiling point of nitrogen is –196°C and that of oxygen is –183°C

(d) Atomic radius of nitrogen is 56 pm, and that of oxygen is 48 pm

Exam model 1

Choose the correct answer for the questions 1 : 21 .... 21 marks

1 Which of the following represents the combination in the gaseous compound Cl_2O ?



2 Which of the following oxides does not react with potassium hydroxide solution ?

ⓐ Al_2O_3

ⓑ Na_2O

ⓒ CO_2

ⓓ P_2O_5

3 Ammonia gas can be prepared through the reaction of ammonium sulphate with ....

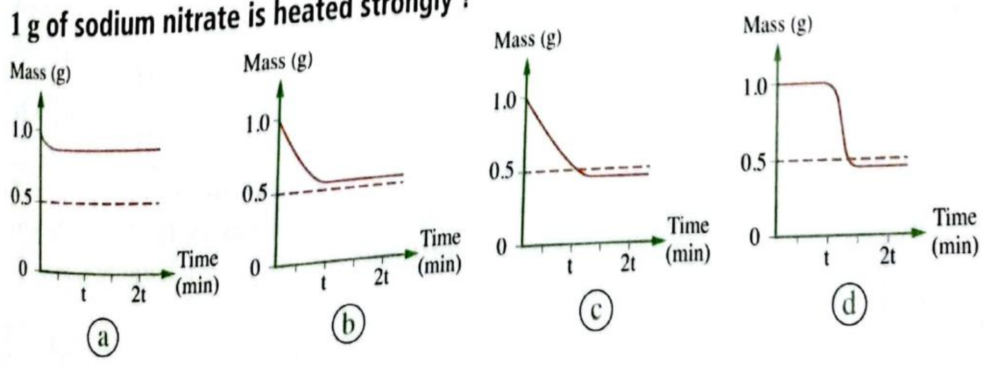
ⓐ limewater.

ⓑ bromine water.

ⓒ dil. hydrochloric acid.

ⓓ acidified potassium permanganate.

4 What is the graphical figure which represents the change in mass that happens when 1 g of sodium nitrate is heated strongly ?



5 Which of the following represents an element its electron configuration is : [Kr] , $5s^1$?

(a) It forms an anion with charge +1

(b) It forms with oxygen an ionic compound.

(c) Its outermost energy level contains one proton.

(d) It reacts only with metals.

6 What is the number of electrons found in the ion $^{31}_{15}X^{3-}$?

(a) 12

(b) 18

(c) 29

(d) 34

7 Which of the following pairs of elements react together more vigorously ?

(a) Cs , Cl

(b) Cs , F

(c) Na , Cl

(d) Na , F

8 A covalent molecule includes : (14 electrons / 1 lone pair of electrons / 2 π bonds).
What is the chemical formula of this molecule ?

(a) C_2H_4

(b) HCN

(c) H_2O_2

(d) N_2

9 Which of the following compounds includes both ionic and covalent bonds ?

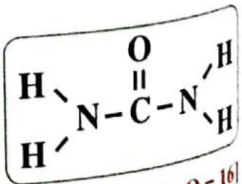
(a) Nitrogen dioxide.

(b) Ammonium sulphate.

(c) Potassium chloride.

(d) Carbon tetrachloride.

10 The opposite structural formula represents a nitrogenous fertilizer.
What is the mass percentage of nitrogen in it ?



[H = 1 , N = 14 , C = 12 , O = 16]

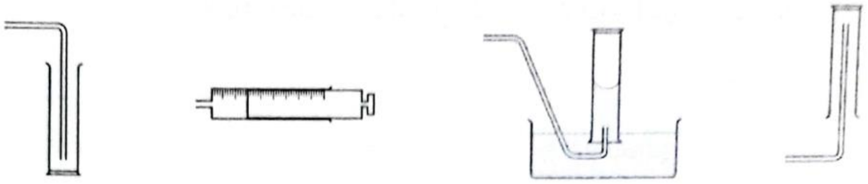
(a) 23.3%

(b) 25%

(c) 43.8%

(d) 46.7%

The following figures represent four different methods of collecting gases :

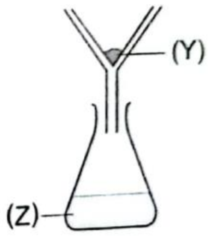


(1) (2) (3) (4)

In which of the following does the method of collecting the gas match its properties ?

Choices	Method	Properties of the gas
ⓐ	(1)	It has lower density than air and dissolves in water
ⓑ	(2)	It has higher density than air and dissolves in water
ⓒ	(3)	It has higher density than water and is insoluble in it
ⓓ	(4)	It has lower density than air and is insoluble in water

An excess of NaOH solution was added to the solution (X), so the precipitate (Y) and solution (Z) were formed which could be separated by the method shown in the opposite figure. Which of the following represents each of (X), (Y) and (Z) ?



Choices	Solution (X)	Precipitate (Y)	Solution (Z)
ⓐ	$CuSO_4$	Na_2SO_4	$Cu(OH)_2$
ⓑ	$CuSO_4$	$Cu(OH)_2$	Na_2SO_4
ⓒ	$AlCl_3$	$Al(OH)_3$	$NaCl$
ⓓ	$AlCl_3$	$NaAlO_2$	H_2O

13 Which of the following bonds is the most polar ?

ⓐ H – O

ⓑ C – N

ⓒ H – C

ⓓ O – N

14 The stereostructure of the following molecules is linear, except ....

ⓐ BeH_2 ⓑ C_2H_2

ⓒ HCN ⓓ O_3

15 Which of the following chemical formulas represents the compound which dissolves easily in water forming ammonia gas ?

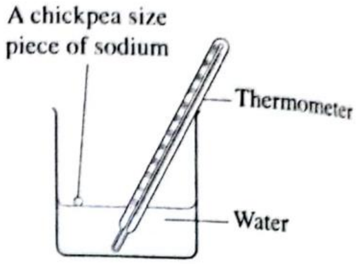
ⓐ MN

ⓑ M_2N

ⓒ M_3N_2

ⓓ M_2O_3

16 The opposite figure shows a chemical reaction. What is the change which occurs in the thermometer reading during the reaction, and to the colour of water when some drops of litmus solution are added to it after the reaction is completed ?



Choices	Thermometer reading	Water colour
ⓐ	Rises	It becomes blue
ⓑ	Drops	It becomes blue
ⓒ	Rises	It becomes red
ⓓ	Drops	It becomes red

17 Which of the following represents nitric acid correctly ?

ⓐ Its colour becomes red when drops of water are added to it.

ⓑ Its concentrated form decomposes by heat forming pure nitrogen dioxide gas.

ⓒ Its concentrated form reacts with aluminum till completion.

ⓓ Its dilute form reacts with iron filings until they are totally consumed.

18 An alloy of copper metal contains 0.5 : 11% of the metal (X) which increases its resistance to corrosion, and 0.01 : 0.35% of the element (Y) to increase its hardness. Which of the following can represent each of (X) and (Y) ?

Choices	(X)	(Y)
ⓐ	P	Sn
ⓑ	Sn	P
ⓒ	Sb	Pb
ⓓ	Pb	Sb

Exam Model

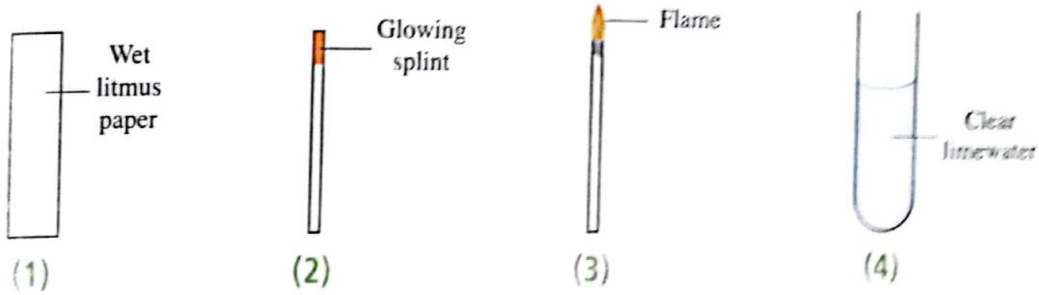
19 The following groups are characteristic for some chemical compounds :

(1)	(2)	(3)	(4)
$\overset{O}{\overset{\|\|}{C}}-OH$	$C-OH$	$-\overset{O}{\overset{\|\|}{C}}-$	$-\overset{O}{\overset{\|\|}{C}}-H$

What are the groups whose presence results in the linkage of the molecules of the same compound with each other by hydrogen bonds ?

ⓐ (1) , (2)
ⓑ (3) , (2)
ⓒ (1) , (4)
ⓓ (3) , (4)

20 Nitrogen gas combines with hydrogen gas forming ammonia gas.
What is the property which distinguishes nitrogen gas from hydrogen gas, and the method of detecting ammonia gas from the following figures ?

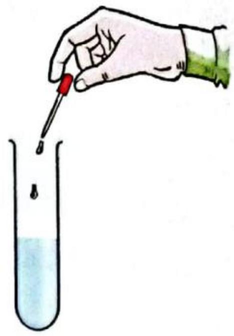


Choices	The property	The method
ⓐ	Non flammable	(1)
ⓑ	Flammable	(2)
ⓒ	Soluble in limewater	(3)
ⓓ	Has a distinctive colour	(4)

21 Which of the following equations represents the reaction of cesium with phosphorus ?

ⓐ $2Cs_{(s)} + 3P_{(s)} \xrightarrow{\Delta} Cs_2P_{3(s)}$
ⓑ $Cs_{(s)} + P_{(s)} \xrightarrow{\Delta} CsP_{(s)}$
ⓒ $3Cs_{(s)} + 2P_{(s)} \xrightarrow{\Delta} Cs_3P_{2(s)}$
ⓓ $3Cs_{(s)} + P_{(s)} \xrightarrow{\Delta} Cs_3P_{(s)}$

22 **A student failed to perform the brown ring test by the following method :**



- He put a little amount of concentrated solution of iron (II) sulphate - from a bottle placed on a shelf - in a test tube.
- He added a little amount of sodium nitrate solution to the test tube.
- He added drops of concentrated sulphuric acid to the reaction mixture directly.

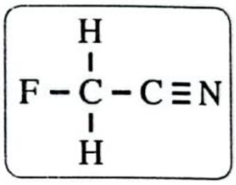
Determine two mistakes in this student's steps which resulted in the failure of the test.

....

....

.... / 2 marks

23 **Re-draw the opposite molecule using Lewis dot diagram, with illustrating** the lone pairs and the bond pairs of electrons.



....

....

....

....

....

....

.... / 1 mark

24 **Potassium bicarbonate decomposes thermally :**

(1) Write the balanced equation which represents this reaction.

....

....

(2) What is the produced gas from the reaction of the formed solution with dilute nitric acid ?

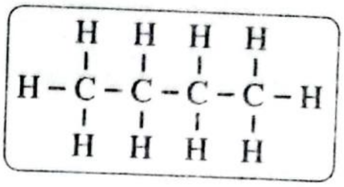
....

....

....

.... / 2 marks

25 **The opposite figure represents** the structural formula of butane C_4H_{10}

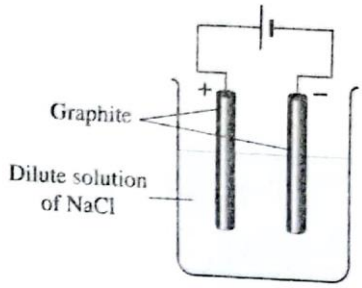


What is the type of the hybridization in the carbon atoms of this compound ?

....

.... 1 mark

26 **The opposite figure shows an electrolysis process of a dilute solution of sodium chloride to obtain sodium hydroxide solution :**



(1) Complete the following ionic equation which illustrates the formation of chlorine gas at the positive electrode.

$$\text{..............} \longrightarrow Cl_{2(g)} + \text{..............}$$

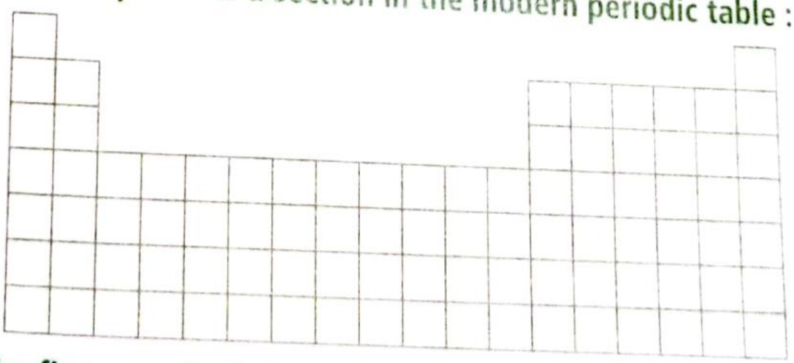
(2) Is the produced sodium hydroxide solution used in purifying acidic or basic impurities ? Explain.

....

....

.... 2 marks

27 **The following figure represents a section in the modern periodic table :**



Determine on the figure each of the following :

(1) One of the alkali metals located in the fourth period «by dotting the box of the element in the table».

(2) A metal in group (5A) «by shading the box of the element in the table».

.... 1 mark

Exam Model (2)

1 **Which of the following statements does not match with the properties of the elements of p-block in the periodic table ?**

(a) The last electron is located in the sublevel *np*

(b) Their metallic property decreases in the same period from left to right.

(c) Their metallic property increases in the same period from left to right.

(d) Most of them tend to form covalent bonds.

2 **Which of the following represents the electron configuration of an alkali metal atom in its ground state ?**

(a) $(n-1)s^2$, $(n-1)p^6$, ns^1

(b) $(n-1)s^1$, $(n-1)p^6$, $(n-1)d^{10}$, ns^1

(c) $(n-1)s^2$, $(n-1)p^6$, ns^1 , np^1

(d) $(n-1)s^2$, $(n-1)p^6$, $(n-1)d^9$, ns^1

3 **$(NH_4)^+$ ion is similar to $(H_3O)^+$ ion in that they both ....**

(a) are anions.

(b) contain only covalent bonds.

(c) are oxidizing agents.

(d) contain a bond arisen by a lone pair of electrons of one of its atoms.

4 **Which of the following represents the correct descending graduation in the percentage of nitrogen in these fertilizers ?**

(a) Urea > ammonium chloride > ammonium nitrate > ammonium nitrite.

(b) Urea > ammonium nitrate > ammonium nitrite > ammonium chloride.

(c) Urea > ammonium nitrite > ammonium nitrate > ammonium chloride.

(d) Urea > ammonium nitrite > ammonium chloride > ammonium nitrate.

5 Zinc hydroxide dissolves in excess of NaOH, unlike iron (III) hydroxide. **Exam Model 2**

What is the pair of ions whose salts can be separated by using a concentrated solution of sodium hydroxide ?

ⓐ Al^{3+} , Zn^{2+}

ⓑ Al^{3+} , Fe^{3+}

ⓒ Cu^{2+} , Fe^{3+}

ⓓ K^{+} , Na^{+}

6 Which of the following two elements can form – separately – the oxide (MO_2) upon burning in pure oxygen ?

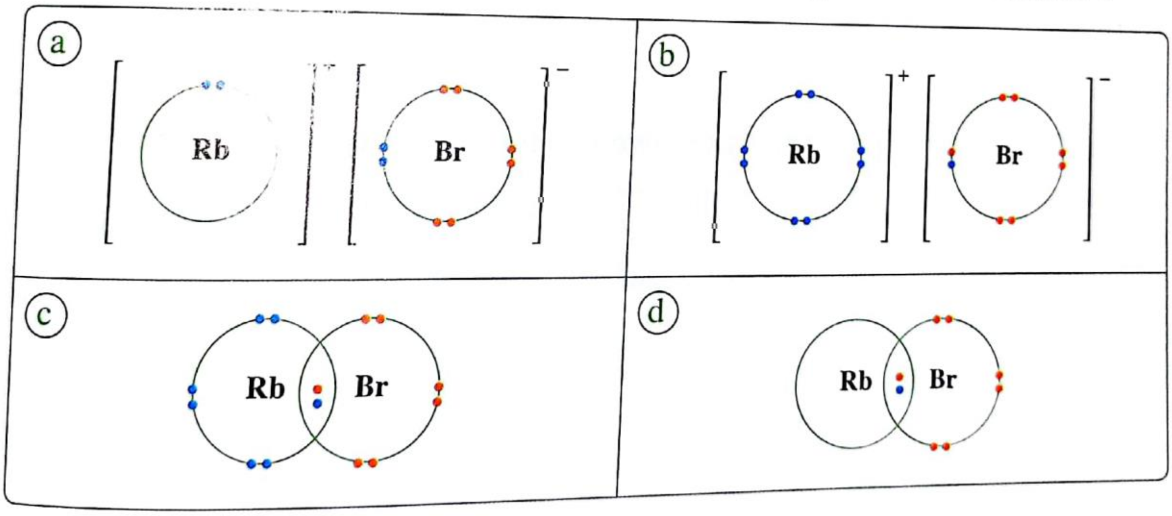
ⓐ C , K

ⓑ C , Na

ⓒ S , Mg

ⓓ Al , S

7 Which of the following represents the chemical bonding in rubidium bromide ?



All the following equations are correct, **except** ....

ⓐ $HNO_{3(aq)} + H_2O_{(\ell)} \longrightarrow H_3O^+_{(aq)} + NO^-_{3(aq)}$

ⓑ $3Cu_{(s)} + 8HNO_{3(aq)} \xrightarrow[\text{dil}]{\Delta} 3Cu(NO_3)_{2(aq)} + 2NO_{(g)} + 4H_2O_{(\ell)}$

ⓒ $Zn_{(s)} + 4HNO_{3(\ell)} \xrightarrow{\text{conc.}} Zn(NO_3)_{2(aq)} + 2H_2O_{(\ell)} + 2NO_{2(g)}$

ⓓ $3NO_{2(g)} + H_2O_{(\ell)} \longrightarrow 2HNO_{2(aq)} + NO_{(g)}$

9 The weakest bonds are found between ....

(a) aluminum atoms.

(b) water molecules.

(c) potassium chloride ions.

(d) neon atoms.

10 During the preparation of ammonia gas from ammonium chloride, calcium hydroxide was replaced by calcium oxide.

How does this affect the products of the reaction ?

(a) Number of NH_3 moles does not change.

(b) Number of H_2O moles does not change.

(c) Number of $CaCl_2$ moles changes.

(d) Water is not produced.

11 In which of the following compounds is the value of the angle between the covalent bonds the highest ?

(a) CCl_4

(b) H_2S

(c) H_2O

(d) NH_3

12 Which of the following represents the two reactions required for preparing the two substances used in the preparation of ammonia gas ?

Choices	(1)	(2)
(a)	$NH_4Cl + Ca(OH)_2 \xrightarrow{\Delta}$	$NH_3 + HCl \longrightarrow$
(b)	$CaO + H_2O \longrightarrow$	$NH_3 + HCl \longrightarrow$
(c)	$CaO + H_2O \longrightarrow$	$NH_4Cl + Ca(OH)_2 \xrightarrow{\Delta}$
(d)	$2NaHCO_3 \xrightarrow{\Delta}$	$CaCO_3 \xrightarrow{\Delta}$

13 BCl_3 has a planar triangle stereostructure, while that of NCl_3 is three-base pyramid, because ....

(a) N – Cl bond is more covalent than B – Cl bond.

(b) B – Cl bond is more polar than N – Cl bond.

(c) nitrogen atom is smaller than boron atom.

(d) BCl_3 molecule does not contain lone pairs of electrons, while NCl_3 molecule contains a lone pair of electrons.

14 The following reactions occur during thunder storms :

(1) $N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$

(2) $2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$

(3) $NO_{(g)} + O_{3(g)} \longrightarrow NO_{2(g)} + O_{2(g)}$

Which of the following represents what happens to nitrogen in equation (1), to nitric oxide in equation (2) and to ozone in equation (3) ?

Choices	N_2	NO	O_3
(a)	Oxidation	Oxidation	Oxidation
(b)	Oxidation	Oxidation	Reduction
(c)	Reduction	Reduction	Oxidation
(d)	Reduction	Reduction	Reduction

15 Which of the following oxides dissolves in water forming a basic solution ?

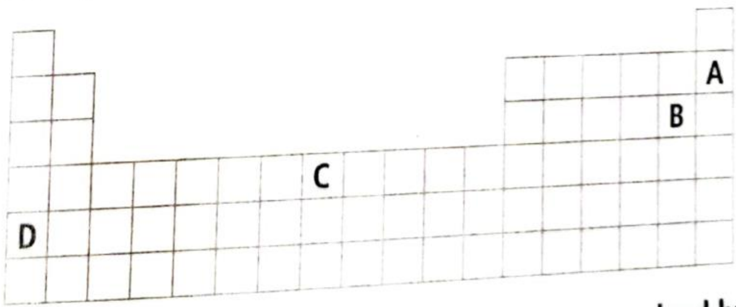
(a) Carbon dioxide.

(b) Nitrogen dioxide.

(c) Sodium oxide.

(d) Sulphur dioxide.

16 The following table represents a section in the periodic table :



What is the letter which indicates the element that is characterized by its softness and its vigorous reaction with water ?

(a) A

(b) B

(c) C

(d) D

17 **Two elements in the periodic table are symbolized by the letters (X) and (Y) :**

- **Element (X) :** Contains seven electrons in its valence shell.
- **Element (Y) :** Contains five electrons in its valence shell.

What is the formula of the compound produced by their combination together ?

(a) Y_2X

(b) Y_3X

(c) YX_2

(d) YX_3

18 **The method of addition of the following fertilizers to the soil is the same, except** ....

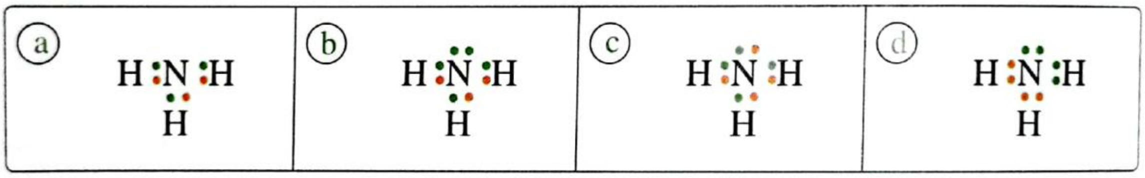
(a) ammonium nitrate.

(b) ammonium sulphate.

(c) the future fertilizer.

(d) urea.

19 **Which of the following represents the electron pairs in ammonia molecule ?**



20 **Which of the following statements is correct ?**

(a) Ammonia gas can be detected upon leakage by its odour.

(b) Dissolution of ammonia gas in water forms a blue solution.

(c) Ammonia gas turns clear limewater turbid when it is passed in it.

(d) Ammonia gas is the anhydride of nitric acid.

21 **Which of the following represents the thermal decomposition reactions of the alkali metals nitrates ?**

(a) All of them decompose completely yielding the metal oxide and oxygen.

(b) They are oxidation-reduction reactions.

(c) The oxidation number of nitrogen changes from (+3) to (+5).

(d) They all are used in producing explosives.

22 Sodium is one of group (1A) elements and among its compounds is sodium carbonate, while magnesium is one of group (2A) elements and among its compounds is magnesium sulphate :

(1) When Mg^{2+} ions are found with SO_4^{2-} ions in an aqueous medium, is the formed compound highly soluble, sparingly soluble or completely insoluble in water ?

....

(2) What is the effect of adding sodium carbonate solution to the mixture mentioned in question (1) ?

....

....

....

.... 2 marks

23 An investor had an idea to extract the alkali metals from their ores, so he was advised to exclude the extraction of four of these metals for economic reasons, in addition to the inability to extract one of them chemically.
Determine one of the excluded metals for economic reasons, and the metal excluded for chemical reasons.

....

....

.... 1 mark

24 Write the balanced symbolic equation which represents the reaction of nitrogen with cesium.

....

....

.... 1 mark

25 Although nitrogen and oxygen gases are the main components of the atmospheric air, but they do not react together except during thunder storms.
What is the scientific explanation for this ?

....

....

....

.... 1 mark

26 Hybridization in boron atom ($_5B$) in BH_3 molecule is sp^2 :

(1) Sketch the orbitals of boron atom in its ground state, excited state and hybridized state.

....

....

....

....

(2) What is the expected value of the angle between the bonds ? **Explain.**

....

....

...... 2 marks

27 The two following figures represent the presence of HF molecules between two metal plates :

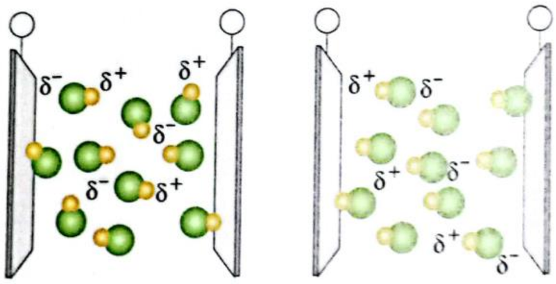


Figure (X) Figure (Y)

(1) Which figure shows the two metal plates when they are electrically charged ? **Determine** the charge type on the figure.

....

(2) Illustrate on the other figure (which you did not choose in the answer of question (1)) an intermittent line to represent the physical bond between the molecules of HF

......